

BIBLIOGRAPHY OF ORGANIC SULFUR COMPOUNDS

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(1871-1929)

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PREFACE

The literature and patent references in this book have been prepared with the intent of presenting a concise summary of the information on sulfur chemistry related to the petroleum industry, through examination of the *Journal of the Chemical Society (London)* for the period 1871 to 1907, inclusive, and of *Chemical Abstracts* for the period 1907 to 1929, inclusive. Every effort has been made to minimize the number of errors. Each literature reference has been checked with the abstract journal, and each patent checked with the official patent file in the U. S. Patent Office at Washington, D. C. Information regarding any errors that may be discovered will be appreciated.

The authors acknowledge with pleasure the helpful suggestions of the members of the Central Petroleum Committee, of the National Research Council, and of the Advisory Committee on Fundamental Research, of the American Petroleum Institute; and the kindness of Dr. A. S. Wheeler in making available his private library for the preparation of a portion of the references. They also desire to express their appreciation to the American Petroleum Institute for financial assistance in the preparation of this bibliography and in publishing it as a service to the petroleum industry.

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SECTION I—LITERATURE

The scope of this literature study has been limited to sulfur compounds which may occur in petroleum and to their properties, uses, and methods of removal from petroleum products. No attempt has been made to include references to sulfur compounds containing nitrogen, sulfur dyes, or biological sulfur compounds, especially where monographs are already available.¹

In general, references are given to the abstract journal first and then to the original publication. The abstracts of the *Journal of the Chemical Society (London)* were used for the period 1871 to 1907, inclusive; and of *Chemical Abstracts* for the period 1907 to 1929, inclusive.

The abstracts of the *Journal of the Chemical Society (London)* are referred to throughout as *B. A.*, and the volume numbers of the references are omitted in the interests of simplicity and brevity. From 1871 to 1877, inclusive, the abstracts appeared as a part of the journal, while from 1878 to 1907, inclusive, they were published separately. During 1876 and 1877 the journal was divided into parts *i* and *ii*, and during the period 1893 to 1907, inclusive, the abstracts were divided into two parts similarly designated; consequently, for these years the reference year is followed by the symbol *i* or *ii* to indicate which section is meant.

For the sake of uniformity and brevity, volume numbers have also been omitted in the references from *Chemical Abstracts*. This publication first appeared in 1907 with Vol. 1, and the volumes are numbered consecutively—one volume for each year.

Years have been omitted in the references to original articles to save space. The abbreviations of the names of the journals are, in general, those contained

¹ For references to sulfur compounds outside the scope of this work the reader is referred to:

Kahn, M., and Goodridge, F. G.

“Sulfur Metabolism—A Review of the Literature.”

Philadelphia and New York, 1926.

Lange, O.

“Die Schwefelfarbstoffe ihre Herstellung und Verwendung.”

Leipzig, 1912.

Meyer, Victor.

“Die Thiophengruppe.”

Braunschweig, 1888.

Raschig, F.

“Schwefel und Stickstoffstudien.”

Leipzig—Berlin, 1924.

Smyth, Geo. A.

“Entwicklung der theoretischen Ansichten über die gepaarten Schwefelverbindungen.”

Berlin, 1876.

Wichelhaus, H.

“Sulfurieren Aklalischmelze der Sulfosauren Esterifizieren.”

Leipzig, 1911.

and to the many standard reference books which contain special chapters devoted to certain classes of sulfur compounds.

in the List of Periodicals, issued by *Chemical Abstracts* in 1926. The volume and page numbers are those given by the abstract publication, except where apparent errors have made a correction necessary.

The abstracts of the *Journal of the Chemical Society (London)* do not cover original articles which appeared in the journal, or the reports of papers carried in the proceedings. The authors have included their own abstracts of pertinent articles in these two publications.

The references have been classified in the groups listed below. In a case where more than one classification for a reference is required, the reference is listed in the first appropriate group, with cross reference entries at the end of the other groups.

1. Determination of sulfur in organic compounds, petroleum, coal, and gas.
2. Reaction of elemental sulfur with organic compounds.
3. Hydrogen sulfide, polysulfide acids, and some of their reactions with organic compounds.
4. Carbon oxysulfide (COS), formation and reactions.
5. Carbon disulfide (CS₂) and carbon monosulfide (CS).
6. Sulfur dioxide as a solvent and reactions with organic compounds.
7. Sulfuryl chloride (SO₂Cl₂) and thionyl chloride (SOCl₂) in reactions with organic compounds where there is an introduction of sulfur into the compound formed.
8. Sulfur dichloride (SCl₂) and sulfur chloride (S₂Cl₂) in reactions with organic compounds where there is an introduction of sulfur into the compound formed.
9. Thiophosgene (CSCl₂).
10. Mercaptans.
11. Mercaptides.
12. Disulfides.
13. Tri and polysulfides.
14. Sulfides.
15. Thiophanes and polymers (primarily ring sulfurs and polymers).
16. Sulfoxides and disulfoxides.
17. Sulfones.
18. Thiophenes.
19. Rings containing more than one sulfur, as thianthrene.
20. Sulfonium compounds.
21. Thioaldehydes and polymers.
22. Thioketones and polymers.
23. Thioacids.
24. Aliphatic acids where there is substitution in the carbon chain of sulfur (mostly of biological value).
25. Sulfonic acids, largely aliphatic and cyclic, with some references to aromatic.
26. Sulfinic acids, both aliphatic and aromatic.
27. Sulfates and a few sulfites.

28. Thiosulfates.
20. Thiocyanates.
30. Isothiocyanates.
31. Miscellaneous.
32. Thioureas.
33. Xanthates.
34. Sulfur compounds found in oils, coal, etc., and references on treating of petroleum and other naturally occurring products.

GROUP 1

DETERMINATION OF SULFUR IN ORGANIC COMPOUNDS, PETROLEUM, COAL, AND GAS

- 1 Allen, A. H. *B. A.* 1888, 627. *Analyst* 13, 43-5. Determination of Sulfur in Oils.
Burned sample in lamp.
- 2 Allen, E. T., and Johnson, J. *C. A.* 1910, 1955. *J. Am. Chem. Soc.* 32, 588-617. The Exact Determination of Sulfur in Soluble Sulfates.
A very exhaustive study of the errors in sulfur determination. The original should be consulted by all interested in exact sulfur determination.
- 3 Allen, I. C., and Robertson, T. W. *C. A.* 1912, 2997. *Orig. Com. 8th Intern. Congr. Appl. Chem.* 10, 25-31. Determination of Total Sulfur in Fuels.
Eight methods are investigated and recommendations made.
- 4 Andrews, H. M. *C. A.* 1918, 761. *Chemist-Analyst* 22, 21-2. Determination of Sulfur in Crude Oil.*
- 5 Angeli, A. *B. A.* 1892, 382. *Gazz. Chim.* 21, ii, 163-5. Estimation of Sulfur in Organic Substances.
Add bromine with nitric acid and reaction goes much faster. See abstract or original.
- 6 Anon. *C. A.* 1921, 1803. *Chem. Trade J.* 68, 304. Sulfur in Benzene.
See abstract for details of apparatus and method.
- 7 Apitzsch, H. *C. A.* 1913, 3944. *Z. angew. Chem.* 26, 503-4. Determination of Sulfur in Organic Compounds.
Substance is burned in current of O_2 with catalysts of Pt on both sides of the boat and the SO_2 absorbed in $Br-NaOH$.
- 8 Bahr and Heide, W. *C. A.* 1925, 1186. *Braunkohle* 23, 812-5. The Rapid Determination of Sulfur in Lignites.*
- 9 Bahr, H., and Heide, W. D. *C. A.* 1925, 796. *Z. angew. Chem.* 37, 848-51. Rapid Determination of Sulfur, Especially in Coal.*
- 10 Bay, I. *C. A.* 1908, 1542. *Compt. rend.* 146, 333. A New Method for the Estimation of Sulfur in Organic Substances.
The substance is decomposed in a combustion tube with Na_2CO_3 and MgO . The product taken into solution with HCl and precipitated as $BaSO_4$.
- 11 Bean, H. J. *C. A.* 1920, 2254. *Am. Gas Assoc. Monthly* 2, 265-8. Quick Accurate Method for the Determination of Hydrogen Sulfide in Gas.
Gas aspirated through 2N $NaOH$, $BaCl_2$ added, acidified with 2N HCl and titrated with 0.1 N Iodine solution.
- 12 Berthelot, Andre, and Matignon. *B. A.* 1890, 1462. *Compt. rend.* 111, 6-9. Oxidation of the Sulfur in Carbon Compounds.
Burned in presence of water in bomb. Sulfur converted to sulfuric acid and determined as barium sulfate.
- 13 Blum, L. *B. A.* 1888, 1333. *Z. anal. Chem.* 27, 445-52. Determination of Sulfur in Coke.
Fusion; 1 part coke, 4 parts sodium carbonate, 8 parts potassium nitrate, and 16 parts sodium chloride.
- 14 Boisselet, L. *C. A.* 1927, 3734. *Ann. Office Nat. Comb. Liquides* 2, 37-45. Determination of Sulfur in Mineral Oils and Liquid Fuels.
A critical review of the different methods with a description of the method used at the laboratory of the Ecole Nationale Sup. du Petrole et des Combustibles Liquides.
- 15 Bowman, S. *C. A.* 1922, 1502. *J. Inst. Petroleum Tech.* 7, 334-8. Estimation

* No attempt has been made to indicate the nature of references marked with an asterisk. The reader is referred to the abstract or the original publication.

of Sulfur and Chlorine by the Lamp Method.
Cotton wick of lamp is burned in a short length of combustion tubing with aid of slow current of air. Products of combustion are absorbed. Chlorine is determined in filtrate after removing BaSO_4 .

16 **Bradbury, W. A., and Owen, F.** *C. A.* 1914, 3853. *Chem. News* 110, 163-5. Estimation of Sulfur in Motor Spirits.* (Modified Referee Apparatus.)

17 **Bradbury, W. A., and Owen, F.** *C. A.* 1915, 1111. *Chem. News* 111, 39-41. Estimation of Sulfur in Motor Spirits. Authors have modified their former apparatus (*C. A.* 1914, 3853). A sketch of apparatus is given.

18 **Bradley, R. E.** *C. A.* 1911, 1241. *Chem. Eng.* 13, 26. Volumetric Sulfur Determinations. Andrews method is inapplicable for sulfur determinations in solutions containing oxidizing agents such as Cl_2 and chlorates. A method is proposed for such cases.

19 **Brugelmann, G.** *B. A.* 1877, i, 492, 741. *Z. anal. Chem.* 15, 175-86; 16, 24. Estimation of Sulfur in Coal Gas. Burned and gases passed through lime to absorb oxides of sulfur.

20 **Brunck, O.** *B. A.* 1905, ii, 762. *Z. angew. Chem.* 18, 1560-2. Estimation of Sulfur in Coal. 1 g. powdered sample is mixed with 2 g. of cobaltic oxide and 1 part of dry sodium carbonate. See abstract for details of method used.

21 **Brunner, R.** *B. A.* 1882, 553. *Z. anal. Chem.* 20, 390. Detection of Sulfur. If a little strong KOH solution and a few drops of commercial nitrobenzene and alcohol are added to a substance containing sulfur, a red coloration will appear after some time in consequence of the reduction of nitrobenzene.

22 **Burton, W. M.** *B. A.* 1890, 289. *Am. Chem. J.* 11, 472-4. Estimation of Sulfur in Organic Compounds. Modification of Sauer's method (*J. Chem. Soc.* 1873, 939).

23 **Christie, A. W., and Bisson, C. S.** *C. A.* 1920, 620. *Ind. Eng. Chem.* 12, 171-2. Rapid Method for the Determination of Sulfur in Petroleum Oils. Method depends upon oxidation of sulfur to sulfuric acid in oxygen-bomb, precipitation of SO_4^{2-} ion as benzidine sulfate, and titration of latter with KMnO_4 .

24 **Conradson, P. H.** *C. A.* 1912, 3324. *Orig. Com. 8th Intern. Congr. Appl. Chem.* 1, 133-6. Apparatus and Method for Sulfur Determination in Petroleum, Illuminating and Lubricating Oils.*

25 **Conradson, P. H.** *C. A.* 1913, 414. *J. Ind. Eng. Chem.* 4, 842-4. Apparatus and Method for Sulfur Determination in Petroleum. Illuminating and Lubricating Oils. See journal. No abstract given.

26 **Cunningham, E. A.** *C. A.* 1911, 3333. *Chem. Eng.* 14, 287. Titration Method for Determining Sulfur in Coal.*

27 **Davis, C., and Foucar, L. J.** *C. A.* 1912, 1114. *J. Soc. Chem. Ind.* 31, 100. Estimation of Free Sulfur. Digest substance under reflux with alcoholic NaCN, remove alcohol, and titrate thiocyanates produced by any well-known method. Results show close agreement with BaSO_4 method.

28 **Dennstedt, M.** *C. A.* 1909, 1625. *Z. angew. Chem.* 22, 677. The Estimation of Sulfur in Coals and Cokes. Lauer's or Dennstedt's method recommended.

29 **Devine, J. M., and Lane, F. W.** *C. A.* 1928, 2261. *Bur. Mines, Repts. Investigations No. 2866*, 3 p. A Comparison of the Results Obtained with the Oxygen-Bomb and Carius Methods in Determining Sulfur in the Heavier Petroleum Oils. Results from oxygen bomb are lower than from Carius method. Conclusions given.

30 **Devine, J. M., and Lane, F. W.** *C. A.* 1928, 2459. *J. Am. Chem. Soc.* 50, 1707-10. Use of the Carius Method for the Determination of Sulfur in Less Volatile Petroleum Oils. Specific directions are given for the use of the Carius method to determine sulfur in the less volatile petroleum oils.

31 **Diamond, W.** *C. A.* 1919, 782. *J. Soc. Chem. Ind.* 37, 336-7. Estimation of Sulfur in Spent Oxide.*

32 **Dickert, M.** *C. A.* 1911, 1989. *J. Gasbel* 54, 182-3. Perhydrol for the Determination of Total Sulfur in Illuminating Gas. 10 cc. perhydrol and 75 cc. NaOH (30° Be.) used to give a liquid containing finely suspended crystals $\text{Na}_2\text{O}_2\cdot\text{SH}_2\text{O}$. Gas to be tested is led through this solution, then acidified with HCl, boiled and sulfur determined as BaSO_4 .

33 **Dickerts, M.** *C. A.* 1913, 547. *Gas World* 57, 755. Determining Sulfur in Coal Gas.*

34 **Ellerton, J. G.** *C. A.* 1912, 1846. *J. Soc. Chem. Ind.* 31, 1012. The Estimation of Sulfur Compounds in Commercial Benzene.*

35 **Esling, F.** *C. A.* 1921, 812. *Chem. Age (Lon.)* 3, 684-5. Estimation of Sulfur by the Lamp Method.*

36 **Fahlberg, C., and Iles, M. W.** *B. A.* 1878, 1005. *Ber.* 11, 1187-90. New Method for Estimation of Sulfur. Fuse in silver dish with 25 g. KOH. When cold, water soluble. Determine as water soluble.

37 **Fazi, R. de.** *C. A.* 1927, 316. *Ann. chim. applicata* 16, 405-6. The Determination of Sulfur in Combustible Liquids.

Eschka method was shown to give lower values than either the Mahler bomb or the Gasparini method. Last two methods give concordant results.

38 Fischer, K., and Hess, W. C.A. 1929, 2281. *Erdöl u. Teer* 5, 83-4. A Source of Error in the Determination of Sulfur in Mineral Oils.
A source of error is in the formation of SO_3 which escapes absorption in the H_2O_2 solution. Conditions are given for its absorption.

39 Foerster, F., and Probst, J. C.A. 1924, 1377. *Brennstoff-Chem.* 4, 357-8. Determination of Sulfur in Coal and Coke.*
Details are given.

40 Fraenkel, A. C.A. 1909, 1587. *J. Gasbel.* 51, 431-5. The Determination of Phosphorus, Sulfur, and Silicon in Acetylene.
Details are given.

41 Francis, C. K., and Crawford, C. W. C.A. 1917, 2272. *J. Ind. Eng. Chem.* 9, 479-81. The Detection and Determination of Sulfur in Petroleum.
Methylene blue test used for detection. Modified Dammer combustion method for determination of sulfur.

42 Friedlander, S. B.A. 1900, ii, 107. *Chem. Zentr.* 1899, ii, 406-7, 629-30. Estimation of Sulfur in Petroleum.
Compares Heusler, Engler, Kiessling, and Ohlmuller methods. Latter is by far the quickest, and it is possible to effect an analysis in 30 minutes.

43 Garrett, F. C., and Lomax, E. B.A. 1906, ii, 123. *J. Soc. Chem. Ind.* 24, 1212-3. Estimation of Sulfur in Petroleum and Bituminous Minerals.
See abstract for details of a fusion with sodium carbonate and calcium oxide.

44 Graefe, E. B.A. 1904, ii, 514. *Z. angew. Chem.* 17, 616-9. Estimation of Sulfur in Oils, Bitumens and Coals.
Bomb method.

45 Griffin, R. C. C.A. 1929, 4332. *Ind. Eng. Chem., Anal. Ed.* 1, 167-9. Determination of Sulfur in Petroleum Oils.
When sulfur is determined by oxygen bomb, part of sulfur is converted to sulfonic acid and is not precipitated by BaCl_2 . This sulfur can be recovered by refluxing filtrate from the Ba precipitation with HCl . Mercaptans cannot be correctly estimated by either the bomb or lamp method.

46 Grunsteidl, E. C.A. 1929, 387. *Z. anal. Chem.* 77, 283-4. A Microchemical Color Test for Sulfur.
Method depends upon conversion of sulfur into CNS and the color developed with dilute FeCl_2 . Details given for carrying out test under microscope.

47 Hackl, O. C.A. 1929, 4795. *Chem. Ztg.* 52, 933-4. Determination of Total Sulfur in Coal.*
An accurate and rapid method for determining the total sulfur in coal.*

48 Hackl, O. C.A. 1929, 4796. *Chem. Ztg.* 53, 366. An Accurate and Rapid Method for Determining the Total Sulfur in Coal.*

49 Hailstone, H. J. C.A. 1913, 1091. *Gas World* 58, 37. Estimation of Sulfur in Coal Gas and Benzol.
Products of combustion from either gas or benzol are led through solution containing H_2O_2 in presence of NH_3 . The resulting SO_3 is precipitated as BaSO_4 .

50 Hallely, W. F. C.A. 1920, 3044. *J. Chem. Soc.* 117, 898-902. Volumetric Estimation of β, β' -Dichloroethylsulfide.*

51 Halliger, M. C.A. 1911, 2423. *Stahl u. Eisen* 30, 1376-8. Determination of Sulfur in Coke.
For cokes containing less than 2% sulfur, author recommends a combination of Eschka and BaCrO_4 methods.

52 Hammarsten, O. B.A. 1885, 914. *Z. physiol. Chem.* 9, 273-309. The Sulfur of Casein and the Determination of Sulfur in Proteids.
Compares various methods. See abstract or original.

53 Hanai, S. C.A. 1929, 357. *Bull. Inst. Phys. Chem. Research (Tokyo)* 7, 915-9. A Microanalytical Method of Estimation of Sulfur in Organic Compounds.

54 Hauser, H. C.A. 1921, 3957. *Anales soc. españ. fis. quím.* 19, 175-91. The Estimation of Sulfur in Oils.*

55 Heinrich, F., and Petzold, F. C.A. 1929, 1592. *Z. anal. Chem.* 76, 120-34. Determination of the Sulfur Content of Gases, Particularly Gases from Coke Ovens.
The method provides for the determination of all gaseous sulfur compounds except thiophene.

56 Hempel, W. B.A. 1893, ii, 187. *Z. angew. Chem.* 5, 393-4. Estimation of Sulfur in Coals and Organic Substances.
Simplification of Berthelot oxygen bomb. Drawing given in abstract.

57 Henriques, R. B.A. 1900, ii, 107. *Chem. Ztg.* 23, 869. Estimation of Sulfur in Organic Substances.
Not good for volatile compounds.

58 Heslinga, J. C.A. 1925, 1771. *Chem. Weekblad.* 22, 98-100. Estimation of Sulfur in Crude Oil and Derivatives.
The sulfur is converted into SO_2 ; the latter is then absorbed in 3% H_2O_2 solution, and the acid formed titrated with 0.025 N Na_2CO_3 .

59 Heusler, F. B.A. 1895, ii, 412. *Z. angew. Chem.* 8, 285-6. Estimation of Sulfur in Petroleum.
Early type of lamp method. Burned lamp 12 hours. Figure given in abstract.

60 Hinterskirch, W. C.A. 1907, 1241. *Z. anal. Chem.* 46, 241-6. Determination of Total Sulfur in Ichthyol Preparations with Sodium Peroxide.
The sulfur is converted with SO_4 by fusion with sodium peroxide and potassium carbonate in nickel crucible; then treated with bromine water and precipitated as BaSO_4 .

61 **Holand, R. B.A.** 1893, ii, 433. *Chem. Ztg.* 17, 99-100, 130-31. Estimation of Sulfur in Organic Liquids.
Substance burned in a boat containing 5 parts BaCO_3 and 1 part KClO_3 . Details like ordinary combustion; boat digested in dilute HCl , and BaSO_4 weighed as such.

62 **Holliger, M. C.A.** 1909, 2281. *Z. angew. Chem.* 22, 1361. Determination of Sulfur in Coal and Coke.
Author claims Dennstedt method is preferable to Brunk method for S determination.

63 **Irwin, W. B.A.** 1901, ii, 473. *J. Soc. Chem. Ind.* 20, 440-42. Estimation of Sulfur in Commercial Benzene Intended for Enriching Illuminating Gas. Lamp method.

64 **Jean, F. B.A.** 1901, ii, 687. *Ann. chim. anal. chim. appl.* 6, 321. Estimation of Sulfur in Oils.*

65 **Johnson, E. S. B.A.** 1906, ii, 709. *J. Am. Chem. Soc.* 28, 1209-20. Estimation of Carbon Disulfide and Total Sulfur in Commercial Benzene.
 CS_2 by xanthate and total by burning in special burner.

66 **DeJongh, A. C. C.A.** 1908, 1104. *Eng. Mining J.* 85, 2. The Determination of Sulfur.
S in ores, etc., determined by fusing in Ni crucible with Na_2O_2 and K_2CO_3 in equal portions. The SiO_2 and Pb and other interfering metals removed, and S precipitated as BaSO_4 .

67 **Kaminer, B., and Zakharenko, A. C.A.** 1927, 1179. *Azerbaidj. Neft. Choz.* 53, No. 5, 73-5. Determination of Sulfur in Petroleum Products.
Description of the technique of a modification of the American lamp method.

68 **Kast, H., and Lagai, F. B.A.** 1894, ii, 476. *Z. anal. Chem.* 35, 470. Estimation of the Sulfur in Earth-nut Oil.
0.5 to 1.0 g. is mixed with 100 cc. fuming HNO_3 and 10 g. KClO_3 is gradually added. Allowed to stand 1 to 2 hours and then carefully heated on sandbath for 12 to 15 hours. Sulfur estimated as usual. Higher results than Carius.

69 **Kattwinkel, R. C.A.** 1928, 677. *Brennstoff-Chem.* 8, 259-60. Determination of Corrosive Sulfur in Motor Benzene.
The Denner method is described, and results are given.

70 **Keiser, E. H. B.A.** 1884, 500. *Am. Chem. J.* 5, 207-8. Estimation of Sulfur in Organic Compounds.
Fuse with KOH in a silver dish; add KNO_3 to complete oxidation.

71 **Kennedy, H. T. C.A.** 1928, 2459. *Ind. Eng. Chem.* 20, 201-2. Determination of Sulfur in Volatile Fuels.*

72 **Kidokaro, T., and Kamiguchi, Y. C.A.** 1927, 3117. *J. Fuel Soc. Japan* 6, 457-77. Determination of Sulfur in Coal.*

73 **Kissling, R. B.A.** 1897, ii, 157. *Chem. Ztg.* 20, 199. Estimation of Sulfur in the Gases Produced by the Combustion of Petroleum.
Burn oil and absorb gases in U-tube with 5% KMnO_4 to oxidize sulfite. Weigh as barium sulfate.

74 **Kleine, A. C.A.** 1907, 1. *Z. angew. Chem.* 19, 1711. New Apparatus for the Determination of Sulfur and Carbon.
A flask for the determination of sulfur by the evolution method is described.

75 **Kocks, W. B.A.** 1887, 396. *Chem. Zentr.* 1886, 894. Determination of Sulfur in Albuminoid Substances.
Carius method gives low results, even after heating for 3 hours at 200°C. Leibig method better.

76 **Kohout, J. F. C.A.** 1927, 3727. *Ind. Eng. Chem.* 19, 1065-6. Nitrogen as a Catalyst in the Determination of Sulfur in Coal by the Bomb-washing Method.*

77 **Komarovskii, A. C.A.** 1908, 2913. *Chem. Ztg.* 32, 770. Rapid Determination of Sulfur in Coal.
Mixture of coal, calcined soda, and cobalt oxide is burned in O_2 in combustion tube. Residue leached with hot H_2O_2 , oxidized with H_2O_2 , and weighed as BaSO_4 .

78 **Komarovskii, A., and Kogon, A. C.A.** 1926, 1312. *J. Lehrkanzeln wiss. Forsch. Odessa* 1925 (4) 5 p. Rapid Determination of Sulfur in Coal.
Sample heated in metal crucible with equal parts of Na_2CO_3 and KMnO_4 for about 50 minutes, product extracted with water and sulfate determined in usual way.

79 **Korsakov, M. C.A.** 1928, 1844. *Neftyanoye Khozyaistvo* 14, 68-81. The Determination of Sulfur in Crude Petroleum and Its Products.
See abstract for procedure.

80 **Kubota, B., and Hanai, S. C.A.** 1928, 3863. *Bull. Chem. Soc. Japan* 3, 168-72. Microanalytical Determination of Sulfur in Organic Substances by Titration.
Sulfur is converted into NiS by heating in a stream of H_2 so that vapors come into contact with Ni. The NiS can be analyzed iodometrically.

81 **Landa, S. C.A.** 1929, 4794. *Chem. Listy* 23, 287. The Detection and Determination of Sulfur in Fuels.
An aqueous solution of ammoniacal AgNO_3 detects sulfides, mercaptans, and thio acids, but is not specific for thiophene in benzene.

82 **Lane, F. W., and Devine, J. M. C.A.** 1928, 1032. *Bur. Mines, Repts. of Investigations* No. 2828, 7 p. Detection of Sulfur in Petroleum and Petroleum Distillates.
A modification of Lassaigne's sodium fusion method using Pb acetate instead of Na nitroprusside. Method is sensitive to sulfur concentrations of only 0.02% to 0.03%.

83 **Langmuir, A. C. B.A. 1900, ii, 310.** *J. Am. Chem. Soc.* **22**, 99-102. Estimation of Sulfur in Bitumens. Criticises method of S. F. and H. E. Peckham (B.A. 1900, ii, 44). Eschka's process best for sulfur in bituminous coals.

84 **Lant, R., and Lant-Ekl, E. C.A. 1922, 813.** *Brennstoff-Chem.* **2**, 330-2. The Determination of Sulfur in Coal.*

85 **Leander, K. J. C.A. 1921, 1066.** *Svensk Kem. Tid.* **32**, 184-5. Determination of Sulfur in the Products from Washing Illuminating Gas.*

86 **Levi, M. G. C.A. 1915, 1157.** *Ann. chim. applicata.* **3**, 9-31. Methods of Analyzing Sulfur. The chief methods are investigated and conclusions given.

87 **Lidoff, A. P. B.A. 1900, ii, 107.** *Chem. Zentr.* **1899**, ii, 493. Estimation of Sulfur in Naphtha. Dissolve sample in ether. Mix thoroughly with KNO_3 and Na_2CO_3 , and then evaporate ether before fusion.

88 **Little, C. E. C.A. 1922, 1855.** *Gas Age-Record* **49**, 463-5. Finding Sulfur Content in Oxide. A new method is proposed based on the reaction—

$$6 \text{NaOH} + 4\text{S} = \text{Na}_2\text{S}_2\text{O}_3 + 2\text{Na}_2\text{S} + 3\text{H}_2\text{O}$$
A volumetric method is also given.

89 **McBride R. S., and Weaver, E. R. C.A. 1913, 2108.** *Gas Age* **31**, 445-9. Determination of Sulfur in Illuminating Gas. A comparison of the merits of the gravimetric, volumetric, and turbidimetric methods of determining sulfur in illuminating gas. Illustrated by curves and other data.

90 **McCabe, C. R. C.A. 1911, 2714.** *Chem. Eng.* **13**, 27. Modifications of Eschka's Method for Sulfur Determination in Coal and Coke. After burning sample with Eschka mixture, mass is dissolved in HCl nearly neutralized with NH_4OH , $\frac{1}{2}$ cc. HF added and precipitated as BaSO_4 with BaCl_2 .

91 **Mabery, C. F. B.A. 1895, ii, 136.** *Am. Chem. J.* **16**, 544-51. Estimation of Sulfur in Volatile Organic Compounds. Modification of Sauer's process (B.A. 1873, 289) improved by Burton (B.A. 1890, 289). Air supplied under pressure and resulting products absorbed in NaOH and titrated.

92 **Mabery, C. F., and Byerley, J. H. B.A. 1896, i, 329.** *Am. Chem. J.* **18**, 141-50. Artificial Production of Asphalt from Petroleum. The determination of sulfur in organic substances by combustion in air forms sulfuric acid as well as sulfuric acid if substance has a high percentage of sulfur. Add a little hydrogen peroxide before titration.

93 **Mabery, C. F. B.A. 1896, ii, 387.** *Am. Chem. J.* **18**, 149-51. Estimation of Sulfur by Combustion in Air. Recommends method.

94 **Magruder, E. W. C.A. 1909, 115.** *Proc. Va. Chemist's Club*, **1**, 53. Rapid Method for the Estimation of Sulfur in Crude Petroleum and Illuminating Oils. A description of Burton's lamp method is given. S in oil is burned to SO_2 and SO_3 and absorbed in Na_2CO_3 solution and titrated with sulfuric acid solution.

95 **Marcussen, J., and Doscher, H. C.A. 1910, 2427.** *Chem. Ztg.* **34**, 417. Determination of Sulfur and Halogen Content of Organic Substances. The Hempel-Graffe method is modified by authors to determine the halogen content in organic substances. Use NaOH to absorb the halogen compounds.

96 **Marek, I. C.A. 1928, 1933.** *Arkiv. Hem. Farm.* **1**, 194-9. Determination of Sulfur in Organic Substances. Sulfur is determined by combustion of organic substance in current of moist O_2 and absorption of acid gases in 2% H_2O_2 . Sulfuric acid is determined gravimetrically or volumetrically.

97 **Marsden, H. C.A. 1914, 3358.** *J. Gas Lighting* **127**, 335. Determination of Sulfur in Spent Oxide.*

98 **Meade, W. J. G. C.A. 1925, 1767.** *Ind. Eng. Chem.* **17**, 497. A Process for Sulfur in Coal. See abstract for procedure.

99 **Melzer, W. C.A. 1927, 640.** *Brennstoff-Chem.* **7**, 313-4. Note on the Determination of Sulfur in Coal by the Method of Bahr and Heide. Sulfur in coal converted into BaS by BaO_2 , from which it is evolved with HCl as H_2S . Latter is absorbed in Cd acetate and determined iodometrically in usual manner.

100 **Meybloom, W. F. C.A. 1912, 2683.** *Gas World* **56**, 401. Direct Estimation of Hydrogen Sulfide in Illuminating Gas. The volume of gas required to decolorize a known volume of standard iodine is measured.

101 **Meyer, A. C.A. 1920, 912.** *Compt. rend.* **169**, 1402-4. Determination of Thiophene in Commercial Benzene. Thiophene is precipitated by a mercuric salt as a complex $\text{SO}_4(\text{HgO})_2 \cdot \text{HgSC}_6\text{H}_4$, titrating excess Hg with NH_4CNS using ferric alum as indicator.

102 **Meulen, H. ter. C.A. 1927, 2179.** *Chem. Weekblad.* **24**, 206-7. An Improvement in the Sulfur Determination of Eschka.*

103 **Mizuta, M. C.A. 1929, 5037.** *J. Soc. Chem. Ind. (Japan)* **32**, 320-5. The Determination of the Total Sulfur in Transformer Oil. Five methods commonly recommended were compared and recommendations given.

104 Moorhouse, W. B. C.A. 1909, 2217. *Progressive Age* 27, 500. Determination of Total Sulfur in Gas.
An outline and comparison of two methods for the determination of S in illuminating gas, giving the essential features, chemical equations, and calculations involved in each.

105 Moorehouse, L. B. C.A. 1910, 378. *Chem. Eng.* 10, 132. The Determination of Total Sulfur in Gas.
Author describes the London Referees test and W. B. Calkin's method for total S and Tutweiler's method for H_2S in gas. A cut of the Calkins apparatus set up for operation is given.

106 Muer, H. F. C.A. 1911, 3618. *J. Ind. Eng. Chem.* 3, 553-7. Determination of Sulfur in Coal by Means of Jackson's Turbidimeter.*

107 Myhill, R. A. C.A. 1913, 1283. *Gas World* 58, 112. The Estimation of Sulfur in Coal Tar.
Consists in mixing 3 g. tar with large excess Na_2CO_3 and gradually heating mixture for 6 hours. Residue is dissolved in HCl and SO_3 precipitated as $BaSO_4$.

108 Mylius, F., and Huttner, C. C.A. 1917, 2148. *Ber.* 49, 1428-43. Rapid Method for the Determination of Sulfur in Illuminating Gas.*

109 Nikolai, N. A., and Vorobye, H. C.A. 1929, 4551. *Izvestiya Teplotekh. Inst.* 1929, No. 3, 91-2. Sulfur Determination in Coal.*

110 Nostitz and Jankendorf. C.A. 1907, 1088. *Z. anal. Chem.* 46, 157-8. Apparatus for the Determination of Sulfur.
A cheap, convenient, and durable apparatus for the determination of sulfur by the evolution method is given.

111 Ormandy, W. R., and Craven, E. C. C.A. 1926, 2575. *J. Inst. Petroleum Tech.* 11, 556-9. Free Sulfur in Benzene.
A modification of the Ormandy method for the determination of free sulfur in benzene is given.

112 Parr, S. W., Wheeler, W. F., and Berolzheimer, R. C.A. 1910, 376. *J. Ind. Eng. Chem.* 1, 689. A Comparison of Methods for the Determination of Sulfur in Coal.
A comparison of the results of the following methods given: 1. Na_2O_2 gravimetric; 2. Eschka; 3. washings from Mahler bomb, gravimetric; 4. Na_2O_2 fusion, photometric. Na_2O_2 method most reliable. Others apparently rank in order named.

113 Parr, S. W., Wheeler, W. F., and Berolzheimer, R. C.A. 1910, 659. *J. Ind. Eng. Chem.* 1, 689. A Comparison of Methods for Determination of Sulfur in Coal.
Tabulated comparisons of the photometric method, fusion with Na_2O_2 and precipitation as $BaSO_4$, precipitation of washings from Mahler bomb, and Eschka method are given.

114 Pattern, W. C.A. 1913, 2298. *Power* 37, 626-7. Testing Oils for Sulfur.
Directions given for the qual. and quant. determination of sulfur in fuel oil. Method involves Na , a saturated solution of Br water and weighing of $BaSO_4$.

115 Peckham, S. F., and Peckham, H. E. B.A. 1900, ii, 44. *J. Am. Chem. Soc.* 21, 772-6. Estimation of Sulfur in Bitumens.
Polemical. Gives improved details.

116 Petersen, J. B.A. 1903, ii, 690. *Z. anal. Chem.* 42, 406-17. Estimation of Sulfur by Hydrogen Peroxide.
Alkaline solution used. Many organic substances such as thiophene; ethyl sulfide, phenyl mercaptan, and ethyl thiocyanate yield no sulfuric acid when treated with alkaline hydrogen peroxide.

117 Planck, G. C.A. 1926, 1899. *Gas Age-Record* 57, 290. A Rapid Method for the Determination of Sulfur in Gas.
Gas passed through 0.5N $KMnO_4$ at given rate and time in seconds required to decolorize $KMnO_4$ recorded. A curve plotting time in seconds against g. sulfur (as H_2S) per 100 cu. ft. gas given.

118 Powell, A. R. C.A. 1922, 1495. *Bur. Mines Tech. Paper No. 254*, 21 p. The Analysis of Sulfur Forms in Coal.
See original paper.

119 Powell, A. R. C.A. 1923, 3243. *Ind. Eng. Chem.* 15, 951-3. Quantitative Determination of Sulfur Forms in Coke.*

120 Prunier, L. B.A. 1890, 290. *Compt. rend.* 109, 904-6. Simultaneous Estimation of Sulfur and Carbon.
Mix sample with 80 to 100 times its weight of $KMnO_4$. SO_2 and CO_2 absorbed.

121 Rogers, V. C., and Dougherty, G. C.A. 1928, 2123. *J. Am. Chem. Soc.* 50, 1231-2. Variation of the Carius Method for the Determination of Sulfur.
The use of $BaCl_2$ or $NaCl$ with the HNO_3 in the Carius method for sulfur is advocated.

122 Rupp, E. C.A. 1909, 296. *Chem. Ztg.* 32, 984. The Carius Estimation of Sulfur.
Instead of adding $BaCl_2$ after oxidation to precipitate SO_4 ion, author adds $Ba(NO_3)_2$ to Carius tube. $BaSO_4$ formed under high pressure and temperature is coarse and easily filtered. Must be washed to remove $Ba(NO_3)_2$.

123 Ryan, W. A. C.A. 1919, 1380. *Chemist-Analyst* 27, 15. Determination of Total Sulfur and Iron in Spent Oxide.
Determined as $BaSO_4$ after decomposition in Parr calorimeter.

124 Sanders, J. M. C.A. 1912, 1843. *J. Chem. Soc.* 101, 358-65. Determination of Sulfur in Petroleum.*

125 Schmid, A. C.A. 1911, 649. *Stahl u. Eisen* 29, 1278-9. Determination of Sulfur in Iron and Steel.
Sulfur is liberated as H_2S and collected in Cd acetate solution. Sulfur then determined in usual way.

126 Schreiber, H. C.A. 1910, 3054. *J. Am. Chem. Soc.* 32, 977-85. Determination of Total Sulfur in Organic Matter.
Material digested with solution of NaOH and NaNO₃, to which Mg(NO₃)₂ is added, and subsequently heated. Appears to have advantage over peroxide method. Results by both methods given.

127 Schulz, F. C.A. 1913, 1802. *Petroleum Rev.* 28, 226. Determination of Sulfur in Petroleum.
Employs Heusler-Engler lamp method with certain modifications. See abstract.

128 Schulz, H. C.A. 1908, 2663. *Arch. ges. Physiol.* 121, 114-6. The Quantitative Estimation of Sulfur in Urine.
Urine decomposed in Kjeldahl flask with fuming HNO₃, cooled, diluted with water and HCl added, and precipitated as BaSO₄.

129 Scott, J. C.A. 1927, 3734. *Petroleum World (Lon.)* 24, 347-8. A New Sulfur Test for Oils.
A discussion of the method for the determination in petroleum products as presented by E. S. Squire (C.A. 1927, 2786).

130 Selvig, W. A., and Fieldner, A. C. C.A. 1927, 2370. *Ind. Eng. Chem.* 19, 729-33. Sulfur in Coal and Coke.*

131 Smith, E. A., and Bain, J. W. C.A. 1929, 2392. *Can. Chem. Met.* 12, 287-8. Determination of Sulfur in Organic Compounds.
The sulfur content of samples of Balsigono-sulfonate was determined by 5 methods. Best results were obtained by Carius method, which was closely followed by Apitzsch method.

132 Smith, T. B. C.A. 1917, 1034. *Gas World* 66, 40. Rapid Determination of Sulfur in Oils and Gases.*

133 Somerville, C. W. C.A. 1911, 372. *J. Gas Lighting* 112, 28. New Process for Rapid Estimation of Sulfur and Hydrogen Sulfide in Illuminating Gas.
Process is based on the reaction SO₂ + 2I + 2H₂O = H₂SO₄ + 2HI.

134 Somerville, C. W. C.A. 1914, 3498. *J. Gas Lighting* 126, 241-2. Determination of Sulfur in Spent Oxide by Combustion.
Sulfur burned in stream O₂, the SO₂ absorbed in alkali, oxidized with H₂O₂, and sulfate determined as BaSO₄ or by titration.

135 Squire, E. S. C.A. 1927, 2786. *J. Soc. Chem. Ind.* 45, 466-9T. A Rapid Method for the Determination of Sulfur in Certain Petroleum Products.*

136 Stavorinus, D. B.A. 1906, ii, 580. *Chem. Zentr.* 1906, i, 705. Estimation of Carbon Disulfide in Benzene.
25 cc. of sample mixed with 70 cc. 96% EtOH, and 10 cc. 2N NaOH. After 30 minutes 5 cc. of conc. H₂O₂ are added, the alcohol is removed by evaporation and sulfate formed estimated as usual.

137 Stavorinus, D. C.A. 1927, 3446. *Gas u. Wasserfach* 69, 740-1. Determination of Free Sulfur in Spent Gas—Purifying Material.*

138 Stoddart, C. W. B.A. 1903, ii, 40. *J. Amer. Chem. Soc.* 24, 852-64. Estimation of Sulfur in Coal.
Atwater-Blakeslee bomb filled with compressed oxygen.

139 Striger, R. M. C.A. 1919, 373. *Chemist-Analyst.* 26, 6. A Rapid Volumetric Method for the Determination of Sulfur in Coal and Coke.*

140 Styms, J. H. C.A. 1925, 885. *Gas (The Hague)* 44, 69-70. Determination of Sulfur in Spent Gas Mass.
Method is based on the use of activated charcoal such as "norite." See abstract.

141 Teune, J. N. E., and Kropf, H. D. C.A. 1918, 861. *Gas World* 68, 21. Estimation of Sulfur in Spent Oxide.*

142 Twisselmann, N. T. C.A. 1919, 1011. *Chem. Ztg.* 42, 588. Determination of the Free Sulfur Content of Spent Oxide.*

143 Tykac, B., and Streit, J. C.A. 1928, 4225. *Paliva a Topeni* 9, 133-5. The Determination of Sulfur in Coal with the Aid of a Turbidimeter.
Procedure given. The agreement of the total sulfur in coal with gravimetric and Eschka methods is very close (less than 0.06% difference).

144 Vohl, H. B.A. 1876, ii, 552. *Ber.* 9, 875-7. Detection of Sulfur in Organic Compounds.
Historical, on different methods for detection of sulfur.

145 Voogd, N. de. C.A. 1929, 1838. *Het Gas (The Hague)* 49, 50. Sulfur Determination.
Coal is mixed with Na₂CO₃ and KClO₃ and ignited in a Ni or V steel bomb and determined as BaSO₄.

146 Wagner, A. C.A. 1907, 1775. *Gummi-Ztg.* 21, 657. On the Estimation of Sulfur in Rubber.
Author shows that by oxidation of sulfur by HNO₃, a considerable amount of sulfuric acid is lost on evaporation of HNO₃. Difficulty overcome by making solution alkaline and evaporating in nickel crucible.

147 Wailes, R. B. C.A. 1922, 3750. *Gas Age-Record* 50, 333. Sulfur in Gas Oil.*

148 Warunis, T. St. C.A. 1911, 1244. *Chem. Ztg.* 34, 1285-6. New Process for the Determination of Sulfur in Organic Compounds.
Material fused with KOH and Na₂O₂ in Ag crucible. Cooled melt dissolved in water, treated with HCl containing Br. Sulfur determined as BaSO₄. Method requires 2 hours and gives excellent results.

149 Warunis, T. S. C.A. 1911, 3024. *Z. anal. Chem.* 50, 270-2. Method for the Determination of Total Sulfur in Coal.*

150 **Watermann, H. I., and Tussenbrock, M. J. van.** *C. A.* 1928, 572. *Erdöl. u. Teer* 3, 743-4. The Behavior of Ethyl Mercaptan, Diethyl Sulfide, and Diethyl Disulfide on Heating.*

151 **Watermann, H. I., and Tussenbrock, M. J. van.** *C. A.* 1929, 5035. *Erdöl. u. Teer* 23, 424-5. Causes of Failures in Sulfur Determinations in Mineral Oils. Polemic against Fischer and Hess (*C. A.* 1929, 2281).

152 **Waters, C. E.** *C. A.* 1921, 594. *Bur. Standards Tech. Paper No. 177.* Sulfur in Petroleum Oils. Origin of sulfur in petroleum, forms in which sulfur occurs, identification and significance of sulfur compounds, determination of sulfur in petroleum.

153 **Weidel, H., and Schmidt, M. von.** *B. A.* 1877, ii, 798. *Ber.* 10, 1131-5. Modification of Sauer's Method for Estimating Sulfur.

154 **Weiss, J. M.** *C. A.* 1909, 2922. *J. Ind. Eng. Chem.* 1, 604-5. Determination of Carbon Disulfide in Benzol. K xanthate is produced from CS_2 by alcoholic solution of KOH heated under reflux. Poured into water, C_6H_6 removed by heat, xanthate changed to sulfate by KOH and Br water, and precipitated as $BaSO_4$.

155 **Woodward, Gladys.** *C. A.* 1929, 4332. *Ind. Eng. Chem., Anal. Ed.* 1, 117-8. Volumetric Estimation of Sulfur in Crude Petroleum. Preparation of solutions and procedure are described.

156 **Zimmerlund, G., and Svanberg, O.** *C. A.* 1923, 703. *Svensk Kem. Tids.* 34, 139-46. A Micro-method for the Determination of Sulfur Using Benzidine.*

GROUP 2

REACTION OF ELEMENTAL SULFUR WITH ORGANIC COMPOUNDS

1 **Allain, L. B. A.** 1896, i, 3. *J. Pharm. chim.* [6]2, 252-5. Sulfur as a Preservative of Chloroform. Saturate chloroform with sulfur, and it may be kept in direct sunlight for months without undergoing change. No carbonyl chloride is formed.

2 **Altschul, J. B. A.** 1896, i, 126. *Z. angew. Chem.* 8, 535-42. Action of Sulfur on Unsaturated Aliphatic Compounds. First part is review of previous work by other experimenters. Saturated fatty acids when heated with sulfur for some time above their melting points are not appreciably acted upon; to obtain reaction must heat above $200^\circ C$. Oleic acid is formed when heated at 130° - 150° with 100% sulfur. Reaction occurs with evolution of H_2S . See abstract.

3 **Anon.** *C. A.* 1918, 2428. *Gas Age*, 42, 198-9. The Feld Process for Recovery of Sulfur.*

4 **Aronstein, L., and Nierop, A. S. van.** *B. A.* 1903, i, 329. *Rec. trav. chim.* 21, 448-59. Action of Sulfur on Toluene and Xylene. Toluene and p-xylene give off H_2S easier than m-xylene when boiled with sulfur. The authors regard the formation of stilbenes and hydrogen sulfide as the primary change in the action of sulfur on toluene and the xylenes. Toluene finally gives tetraphenyl thiophene. Read abstract or original for details.

5 **Auger, V.** *C. A.* 1908, 1533. *Compt. rend.* 146, 477. A New Type of Combination of Sulfur with Certain Iodides.

The following compounds were obtained: $CH_3 \cdot 3S_8$; $Cl_2 \cdot Cl_2 \cdot 4S_8$; $ASl_3 \cdot 3S_8$ and $SbI_3 \cdot 3S_8$.

6 **Barbaglia, G. A. B. A.** 1881, 34. *Ber.* 13, 1574. Thiovaleraldehyde. Schroeder (*Ber.* 4, 402) describes a solid thiovaleraldehyde obtained by action on valeraldehyde with H_2S . By heating valeraldehyde and S at 250° in sealed tubes a clear $C_5H_{10}S$ was obtained. Disagreeable odor. Some valerenic acid is formed during reaction.

7 **Barbaglia, G. A. B. A.** 1885, 136. *Ber.* 17, 2654-5. Thiovaleraldehyde. Continuation of previous work (*B. A.* 1881, 34). Sulfur reacts with valeraldehyde at 250° . If temperature is raised hydrogen sulfide is given off, a heavy oil boiling between 200° and 300° and trithiovaleraldehyde are formed.

8 **Barbaglia, G. A. B. A.** 1887, 462. *Gazz. chim. ital.* 16, 426-30. Action of Sulfur on Aldehydes. Thiovaleraldehyde and sulfur formed trithiovaleraldehyde ($C_5H_6S_3$). This is supposed to be a secondary reaction between thiovaleraldehyde and sulfur.

9 **Barbaglia, G. A. B. A.** 1889, 120. *Gazz. chim. ital.* 18, 85-8. Action of Sulfur on Para-isobutaldehyde. Sulfur has no action on the paraldehyde of isobutyl aldehyde at 150° . When heated for a long time, 100 hours or more at 180° , change occurs. Isothiobutaldehyde, and isobutyric acid and a fraction unidentified (may be a ring sulfide).

10 **Barbaglia, G. A., and Marquardt, A. B. A.** 1891, 1049. *Ber.* 24, 1881-3. Action of Sulfur on Benzaldehyde.

Benzaldehyde and sulfur are heated in sealed tubes for 36 hours. No appreciable H_2S given off. See abstract for many references.

11 Baumann, E., and Fromm, E. B.A. 1895, i, 337. Ber. 28, 890-5. Thiophene Derivatives.

Any compounds containing double bond react readily with sulfur when heated to form thiophene derivatives. Action of sulfur on unsaturated hydrocarbons.

12 Baumann, E., and Fromm, E. B.A. 1897, i, 191. Ber. 30, 110-17. Action of Sulfur on Unsaturated Organic Compounds. Bisulfide of Thiobenzoyl-thiatic Acid.

Heat ethylcinnamate with sulfur; forms bisulfide of thiobenzoylthioacetate. On distillation yields acetophenone. Small amounts of thioacetophenone and diphenylthiophene formed at the same time as the disulfide is prepared.

13 Baumann, E., and Klett, M. B.A. 1892, 184. Ber. 24, 3307-14. Stilbene, Thionssal and Tolallyl Sulfide (Tolane Sulfide).

When polymeric thiobenzaldehyde, which melts at $83^{\circ}-90^{\circ}$, is heated to 150° , it is decomposed into sulfur and stilbene. At 200° , H_2S is evolved and thionessal is formed. Tolallyl sulfide cannot be obtained by further heating stilbene or thionessal with sulfur. Formed by heating phenylacetic acid with sulfur or by heating benzyl sulfide or disulfide.

14 Bellucci, G. B.A. 1875, 131, Gazz. chim. ital. 4, 179-82. Action of Sulfur on Calcium Carbonate.

Calcium carbonate and precipitated sulfur slowly form calcium sulfate. If organic matter is present, the action takes place in less time.

15 Benedikt, R., and Ulzer, F. B.A. 1887, 914. Monatsh. 8, 208-17. Turkey Red Oil.

Sulfoleic acid was prepared by heating pure oleic acid (10 parts) at $200^{\circ}-220^{\circ}$ with sulfur (1 part). H_2S was evolved. Oxidized with potassium permanganate in alkaline solution formed sulfohydroxystearic acid.

16 Berthelot, M. B.A. 1872, 980. Ann. chim. phys. [4] 26, 462-70. Thermic Researches on Sulfur.

Sulfur dissolved in CS_2 on exposure to sun's rays, light of voltaic arc, or burning magnesium gives rise to insoluble sulfur. Calls this "soluble amorphous sulfur." Discusses the heat changes in its transformations.

17 Birch, S. F., and Norris, W. S. C.A. 1926, 2582. Oil and Gas. J. 24, No. 28, 148, 150, 152-6. Chemistry of the Hypochlorite Process.

$HClO$ is the active agent in a solution of $NaClO$. Org. sulfides are converted into sulfones, and mercaptans into disulfides. Free sulfur does not react with $NaClO$. Converts H_2S partly into H_2SO_4 . Does not react with thiophene.

18 Boeseken, J. C.A. 1911, 3399. Rec. trav. chim. 30, 137-41. Action of Sulfur on Aromatic Sulfones.

Ph_2SO_2 when heated with sulfur gives Ph_2S almost quantitatively. Its p,p' halogen and methyl derivatives react in an entirely different manner, the former giving dihalogen substitution products of C_6H_6 and the latter H_2S .

19 Bottger, H. B.A. 1884, 1282. Ann. 223, 346-8. Action of Sulfur on Sodium Mercaptide.

Sulfur heated at 100° with sodium mercaptide in the presence of absolute alcohol yields ethyl disulfide and sodium polysulfides. No sodium mercaptide was prepared by the action of ethyl sulfide on sodium sulfide, of mercaptan on sodium hydrosulfide, of ethyl sulfide on sodium hydrosulfide, and of sodium sulfide on mercaptan.

20 Bottger, H. B.A. 1884, 1282. Ann. 223, 348-54. Ethyl Sulfides.

Ethyl sulfide does not act on S on heating at 150° for 4 days. At 180° for 24 hours obtain di, tri, tetra, and probably also penta sulfide. Sulfur chloride reacts violently with it, causing decomposition and ethyl polysulfides. Decomposition also occurs with sulfurous dichloride and sulfuric hydroxychloride.

21 Brenner E. C. C.A. 1921, 1800. Am. Gas. J. 114, 339-40, 348-9. Removal of Sulfur Compounds.

Hypochlorites were investigated as agents for removal of sulfur compounds in carbureted water gas. Removes completely H_2S .

22 Broker, H. R., and Kowalke, O. L. C.A. 1922, 1653. Gas Age-Record 49, 386-7. Removing Sulfur from Gas by Sodium Hypochlorite.

A removal of 67% was obtained. A greater amount could be removed if the rate of flow of gas was cut down or the tower enlarged.

23 Brugnatelli, T., and Pellogio, P. B.A. 1875, 735. Gazz. chim. ital. 4, 536-40. Action of Sulfur on Calcium Carbonate in Presence of Water.

Oxidation takes place at the expense of the oxygen of the water, and not as Pollacci supposed by means of atmospheric oxygen. Pentathionic and tetrathionic acids are formed before the sulfuric acid.

24 Budnikoff, P. P., and Schilow, E. A. C.A. 1923, 1005. Ber. 55B, 3848-53. Action of Sulfur and a Few Sulfur Compounds of Terpenes.*

25 Cabot, S. B.A. 1877, ii, 867. Chem. News 36, 114. Action of Sulfur at High Temperatures on Normal Paraffins.

High temperature sulfur and heptane give off hydrogen sulfide. No polymers found.

26 Capelle, C. C.A. 1908, 1562. Bull. soc. chim. [4] 3, 150-4. Contribution to the Study of the Action of Sulfur on Hydrocarbons.

Purified acetylene is led into retort containing S, which is heated. Distillate is caught in CS_2 . Chief product is thiophene, $C_6H_4S_2$; prepared by Biedermann and Jacobsen by action of P_2S_3 on citric acid.

27 Coninck, W. O. de. C.A. 1909, 643. Bull. acad. roy. Belgique. Classe sci. 1908, 303. Action of Sulfur on Acetylene.

Confirmation of G. Capelle's observation (*C. A.* 1908, 1562) that thiophene is not produced from C_2H_2 and S.

28 Delaplace, R. *C. A.* 1922, 4110. *J. pharm. chim.* **26**, 139-40. Solubility of Sulfur in Some Organic Liquids. The solubility of sulfur in $CHCl_3$, CCl_4 , $PhMe$, benzine, and Et_2O (anhdyd.) given.

29 Delepine, M. *C. A.* 1922, 2481. *Compt. rend.* **174**, 1291-3. The Autoxidation of Organic Sulfur Compounds.*

30 Delepine, M., and Giron, J. *C. A.* 1924, 1114. *Bull. soc. chim.* **33**, 1785-92. Chlorosulfides of Carbon: Decomposition in the Presence of Iron. The action of these various sulfides in presence of Fe is given.

31 Delepine, M. *C. A.* 1925, 40. *Bull. soc. chim. Belg.* **33**, 339-65. Autoxidation of Organic Sulfur Compounds.*

32 Dziewonski, K. (with Paul Bachman). *B. A.* 1903, i, 431. *Ber.* **36**, 962-71. Decacyclene (Trinaphthylene Benzene) and Dinaphthylene Thiophene. 100 g. acenaphthene and 23 g. finely powdered sulfur slowly heated. At 205° H_2S is evolved and mass becomes brown. When H_2S ceases, heat to 290° . Gives method of separation and purification.

33 Engelhardt, A. *C. A.* 1921, 3198. *Brennstoff-Chem.* **2**, 186. The Transformation of Hydrogen Sulfide to Sulfur by Means of Activated Carbon—A New Process of Sulfur Recovery and Gas Purification.*

34 Ephriam, F. *C. A.* 1908, 2345. *Z. anorg. chem.* **58**, 338-52. The Non-existence of Compounds of Sulfur with Iodine. Author claims such reported compounds are only mixtures of the original substances.

35 Erdmann, H. *C. A.* 1908, 3069. *Ann.* **362**, 133-73. Thiozonides, a Contribution to our Knowledge of Sulfur and its Cyclic Compounds. Thiozone S:S:S is regarded as the most reactive form of sulfur. Was studied by its action on unsaturated organic compounds. Plastic S is polymerized amorphous S. These rings break down at 160° forming S_3 , thiozone, analogous to ozone.

36 Fischer, E. *B. A.* 1878, 302-13. *Lie. Ann.* **1903**, 67-183. On Certain Hydrazine-compounds. Phenylhydrazine and sulfur at 130° gave nitrogen, ammonia, hydrogen sulfide, benzene, thiophenol, diphenyl sulfide, diphenyldisulfide, and aniline.

37 Forster, M. O., and Jackson, T. *C. A.* 1908, 838. *Proc. Chem. Soc.* **23**, 242. Studies in the Camphane Series, XXIV. Camphoryl dithiocarbamic acid and camphorylthiocarbamide. Former when heated resolved into camphorylthiocarbamide and $MeSH$. Also converted into thiocarbamide by HNO_2 .

38 Friedel, C., and Crafts, J. M. *B. A.* 1878, 670. *Compt. rend.* **86**, 884-7. Direct Union of Oxygen and Sulfur with Benzene and Toluene. Benzene, sulfur, and aluminum trichloride at 75° - 80° gave thiophenol, diphenyl sulfide, and diphenylene disulfide.

39 Friedmann, W. *C. A.* 1916, 896. *Ber.* **49**, 50-3. Action of Sulfur on Indene, Hydrindene, and Cyclopentadiene. 100 g. indene and 28 g. sulfur heated until reaction begins, boiling allowed to cease; then heated 2 to 3 hours at 180° - 185° . Diindene thiophene was obtained. Other compounds given.

40 Friedmann, W. *C. A.* 1916, 2719. *Ber.* **49**, 683-91. Action of Sulfur on Indene, Hydrindene, and Cyclopentadiene, II. 2 mol. indene and 2 atoms sulfur at 180° gave a compound $C_{36}H_{22}S$, sinters at 140° ; with 1 mol. indene at 180 - 5° , $C_{36}H_{24}S_3$ and at 210° , $C_{27}H_{20}S$ are formed. Other reactions given.

41 Friedmann, W. *C. A.* 1917, 940. *Ber.* **49**, 1344-52. Action of Sulfur on Octane under Pressure. Small amounts of a thiophene $C_8H_{12}S$ and a thiophene C_8H_8S were obtained. Mechanism of formation discussed. Reactions of above products with $HgCl_2$, Br , and $KMnO_4$ given.

42 Friedmann, W. *C. A.* 1917, 941. *Ber.* **49**, 1352-5. Action of Sulfur on β -Methyl Naphthalene under Pressure. α - $C_{10}H_7Me$ heated 72 hours at 320° without opening tubes gave a compound $C_{12}H_{14}S_2$ long needles from cumene, m. p. 332° . β - $C_{10}H_7Me$ under the same conditions gave the isomers of the products obtained above, m. p. 350° . Other compounds given.

43 Friedmann, W. *C. A.* 1917, 1958. *Ber.* **49**, 1551-4. Action of Sulfur on Octylene under Pressure. No definite results were obtained from the action of sulfur under pressure on an octylene precipitated from octyl iodide. Caprylene and sulfur at 270° - 280° for 24 hours gave $C_8H_{12}S$ and $C_8H_8S_2$ and a compound $C_{16}H_{28}S$.

44 Friedmann, W. *C. A.* 1917, 3424. *Petroleum* **11**, 693-7. Reactions between Sulfur and Olefin under Pressure. Reactions between hexylene, octylene and hexadecylene, and sulfur are given; also the products formed therefrom.

45 Friedmann, W. *C. A.* 1928, 582. *Brennstoff-Chem.* **8**, 257-9. Dehydrogenation by Means of Sulfur. Along with dehydrogenation side reactions often take place. Sulfur combines with the dehydrogenated residue, polymerization may take place, and sulfur will react with olefins present.

46 Fromm, E., and Schmoldt, P. *C. A.* 1907, 2579. *Ber.* **40**, 2861-70. Thiobenzoic Acids. Preparation of Bz_2S and Bz_2S-SBz_2 given. Thiobenzoic acid, benzoyl sulfide, benzoyl disulfide when distilled yield, in each case, H_2S , benzoic acid, and tolane tetrasulfide. Hot KOH converts latter into tetraphenyl

thiophene and sulfur. Thiobenzoyl disulfide with alc. KOH yields dithiobenzoic acid, S, and H_2S .

47 **Fromm, E., and Wittman, J.** *C. A. 1908*, 2932. *Ber.* **41**, 2264-7. Derivatives of p-Nitrothiophenol. p-Nitrochlorbenzene, S, EtOH, NaOH, and H_2O when boiled yield sodium p-nitrophenolate, 4,4'-dinitrodiphenyl disulfide, nitroaminodiphenyl sulfide, p-dinitrodiphenyl disulfide, and p-azobenzene mercaptan 4,4'-dinitrodiphenyl ether. The action of oxidizing agents gives the sulfone. Other derivatives given.

48 **Genresse, P.** *B. A. 1899*, **i**, 147. *Bull. soc. chim.* [3] **17**, 599-609. An Isomeride of Diphenylene Disulfide. Prepared by the action of sulfur on benzene in presence of aluminum chloride. Remove by boiling with glacial acetic acid to remove one isomeride. Can be oxidized to disulfone. See abstract.

49 **Graebe, C., and Von Mantz, B.** *B. A. 1896*, **i**, 442. *Ann.* **290**, 238-46. Action of Bromine, Chlorine, and Sulfur on Fluorene. On heating fluorene with sulfur, hydrogen sulfide is evolved and bidiphenylethane or bidiphenylethylene is produced according to the amount of sulfur employed.

50 **Guislin, M. A.** *C. A. 1913*, 3017. *Petroleum Rev.* **28**, 486. Action of Sulfur on Petroleum. Sulfur is fairly soluble in petroleum at low temperatures, about 1.5% in light distillates at 70° F. In heavier oils the percent is higher, and increases with rise in temperature. On distilling oil in which sulfur is dissolved H_2S is formed. Author concludes chemical action of sulfur in petroleum distillates due to presence of naphthenic acids.

51 **Guyot-Dannecy.** *B. A. 1883*, 241. *J. pharm. chim.* [5] **6**, 336-7. Analysis of Potassium Thiocarbonate. Drive off CS_2 and at the same time forms ZnS which is weighed.

52 **Haitinger, L.** *B. A. 1883*, 988-90. *Monatsh.* **4**, 165-75. Action of Sulfur on Sodium Phenate. Sodium phenate 2 mol. and sulfur 1 mol. yield on heating hydroxyphenyl mercaptan, but it is recovered as disulfide, due to oxidation. Gives properties of hydroxyphenyl mercaptan. Decomposes carbonates. See abstract.

53 **Hamilton, E. R.** *C. A. 1921*, 3383. *Am. Gas J.* **115**, 182-3. Sulfur Removal by Oil Washing.*

54 **Herzog, W.** *C. A. 1920*, 2620. *Z. angew. Chem.* **33** (1), 140. The Desulfurization of Organic Compounds with Arsenic Trioxide. Details for the desulfurization of thiocarbonilide are given.

55 **Himmelbauer, A.** *C. A. 1909*, 2446. *Centr. Min.* **1909**, 396. Phenyl Sulfide (As a Liquid with High Refractive Index). Has a refractive index of 1.65 and not 1.950. Addition of S gave the value 1.641.

56 **Hofmann, A. W.** *B. A. 1880*, 884-7. *Ber.* **13**, 1223-40. Amidophenyl Mercaptans or Thiohydranilines. See also *B. A. 1880*, 386, *Ber.* **12**, 2359-65. Gives methods of preparation and reactions. See abstracts for reaction of this class of compounds.

57 **Hofmann, A. W.** *B. A. 1887*, 839. *Ber.* **20**, 1798-1805. Amidonaphthyl Mercaptans. Prepared by heating 2 parts naphthylbenzamide with 1 part of sulfur.

58 **Hofman, K. A.** *B. A. 1895*, **i**, 87. *B. A. 1894*, **i**, 132. *Ber.* **27**, 2807-16; 3320-4. Thioaniline (M. P. 105°) and a New Isomeride. Studied products formed on heating aniline with sulfur forming sulfide and disulfide.

59 **Holmberg, B.** *C. A. 1910*, 1047. *Ber.* **43**, 220-6. Action of Sulfur and Ammonia on Organic Sulfides and Disulfides. $(EtS)_2$ dissolve S, ultimately giving ethyl tetrasulfide. Toluyl disulfide reacts similarly. Ethyl dithioacetate yields the amide and sulfur.

60 **Houben, J., and Doescher, H.** *C. A. 1907*, 304. *Ber.* **39**, 3503-9. Hydrophenesulfinic Acid, Hydrophenine Carbithioic Acid, Thioborneal, and Thio-camphor. The acids were prepared by action of SO_2 , and CS_2 on hydrophenine magnesium chloride. The Grignard reagent + sulfur yields thioborneal. Chromic acid converts the latter into bornyl disulfide and thio-camphor. These compounds are unstable.

61 **Keilpflug, J.** *C. A. 1909*, 2370. *Chem. Ztg.* **33**, 301. Note on the Use of o-Dichlorobenzene for Extracting Sulfur from Iron Oxide Mass Gas Purifiers. Not suited because its b.p. is too high for effective distillation with steam.

62 **Keutgen, C. H.** *B. A. 1890*, 577. *Arch. Pharm.* [3] **28**, 1-7. Action of Sulfur on Glycerol. No appreciable reaction below 285° but at 290°-300° reaction rapid. Allyl mercaptan b. p. 90° identified. Diallylhexasulfide also found which on oxidation yielded a sulfoxide. This on reduction gave allyl-sulfide.

63 **Klason, P.** *B. A. 1887*, 1015. *Ber.* **20**, 2376-83. Action of Chlorine on Carbon Disulfide and Sulfur on Carbon Tetrachloride. See abstract for details in preparation of thiophosgene, trichlormethyl disulfide, etc.

64 **Klinger, H.** *B. A. 1878*, 128. *Ber.* **10**, 1880-1. Action of Methyl Iodide upon Sulfur. Heating 2 mol. of methyl iodide and 1 mol. of sulfur in sealed tubes to 160°-190° trimethylsulfur iodide was formed.

65 **Kohler, H.** *B. A. 1878*, 372. *Ber.* **11**, 205-6. Behavior of Hydrogen Sulfide with Carbon Dioxide at a Red Heat. Equal volumes passed through tube heated to redness gives water, carbon monoxide, and sulfur.

66 **Krafft, F., and Vorster, W.** *B. A. 1894*, **i**, 88. *Ber.* **26**, 2813-22. Conver-

sion of Diphenyl Sulfone into Diphenyl Sulfide and Diphenylic Selenide.

Diphenyl sulfone heated with sulfur forms diphenyl sulfide and diphenyl disulfide. Dimethyl sulfone also reacts with sulfur, but not dipara or dimetatolyl sulfones. Phosphorus does not react below 250° C. Selenium reacts but not tellurium. See abstract and original.

67 **Krafft, F., and Steiner, O.** *B.A. 1901*, ii, 235. *Ber.* 34, 560-5. Replacement in the Sulfur-selenium-tellurium Group.

Ph_2Se heated nearly to the boiling point with sulfur diphenyl sulfide is produced. Reaction quantitative at 300°. Phenyl telluride likewise. Phenyl oxide with sulfur forms phenyl sulfide also. See abstract.

68 **Lang, W.** *B.A. 1892*, 1079. *Ber.* 25, 1902-3. Oxalylorthamidophenyl Mercaptan and Oxalylorthamide α -naphthyl Mercaptan.

Prepared when aniline, glycerol, and sulfur are heated to the boiling point. H_2S comes off for 50 to 60 hours.

69 **Merz, V., and Weith, W.** *B.A. 1871*, 566. *Ber.* 4, 384. On Thioaniline and Thiotoluidine.

Studied reaction of aniline and toluidine with sulfur. Gives products formed and properties. Benzine vapor passed through boiling sulfur gives off H_2S and a small amount of an oil smelling like mercaptans. P_2S_5 also yields H_2S with benzene and forms sulfuretted body containing phosphorus.

70 **Meyer, V., and Sandmeyer, T.** *B.A. 1884*, 45. *Ber.* 16, 2176. Artificial Formation of Thiophene.

Pass ethylene or acetylene through boiling sulfur and hydrogen sulfide, carbon disulfide and a small quantity of an oil resembling thiophene is formed. Gives the color reaction with isatin and sulfuric acid, dye stuffs with benzoyl cyanide and sulfuric acid.

71 **Michael, A.** *B.A. 1895*, i, 509. *Ber.* 28, 1633-7. Addition of Sulfur to Unsaturated Organic Compounds.

Various unsaturated organic compounds combine with sulfur by heating them with it in a sealed tube for 20 hours at 150°-210°. Most compounds studied were unsaturated acids.

72 **Morris, G. H.** *Proc. Chem. Soc.* 5, 102. The Product of the Action of Sulfur on Resin.

Obtained a hydrocarbon.

73 **Norrish, R. G. W., and Rideal, E. K.** *C.A. 1923*, 1930. *J. Chem. Soc.* 123, 696-705. Conditions of Reactions of Hydrogen and Sulfur.

Combination below the b. p. of sulfur takes place by way of two reactions: 1. gaseous reaction proportional to pressure of the H_2 ; 2. a surface reaction independent of the pressure of hydrogen.

74 **North, H. B., and Thomson, J. C.** *C.A. 1918*, 2291. *J. Am. Chem. Soc.* 40, 774-7. Action of Thionyl and Sulfuryl Chlorides on Sulfur and Phosphorus.

React with sulfur at 160°-180° forming S_2Cl_2 and SO_2 . Under similar conditions they react with P, either red or yellow, to give PCl_5 .

75 **Onufrowicz, S.** *B.A. 1889*, 404. *Ber.* 21, 3559-63. β -Naphthol Sulfide. Prepared by heating β -naphthol and sulfur at 170°-180° for some hours. Heated with copper at 230°-240°, β -dinaphthol is formed.

76 **Onufrowicz, S.** *B.A. 1891*, 320. *Ber.* 23, 3355-73. Sulfides of β -Naphthol. Prepared by action of sulfur dichloride or sulfur and lead oxide on β -naphthol.

77 **Peel, J. B., and Robinson, P. L.** *C.A. 1928*, 4460. *J. Chem. Soc.* 22, 2068-70. Reaction between Acetylene and Sulfur at Temperatures up to 650°. CS_2 and thiophene were formed in varying amounts at different temperatures.

78 **Pfankuch, F.** *B.A. 1871*, 895. *J. prakt. Chem.* [2] 4, 35. New Modes of Formation of Hydrocarbons.

Sulfur when heated with barium salts of organic acid, such as benzoic acid, forms hydrocarbons and some sulfur compounds not identified.

79 **Pfankuch, F.** *J. Chem. Soc.* 1871, 901. *J. prakt. Chem.* [2] 4, 38. A Sulfoform and Cyanoform.

Iodoform heated with sulfur in sealed tube gave a compound of formula of $\text{C}_2\text{H}_2\text{S}_3$ from analysis.

80 **Pfankuch, F.** *B.A. 1873*, 362-3. *J. prakt. Chem.* [2] 6, 97-116. New Organic Compounds and New Modes of Preparing Them.

CHCl_3 and alc. K_2S react with explosive violence. Distilled S and barium benzoate giving 90% yield tolane C_4H_{10} . Gives method of purification. From S and barium acetate and subsequently removing S from product by Cu or Pb, divinyl is obtained. Studied action of metallic sulfocyanates on metallic salts of acid. Various products found.

81 **Pishchimuka, P. S.** *C.A. 1926*, 2816. *J. chim. Ukraine* 1, 87-9. The Formation of Mercaptan According to Kekulé.

EtOH and P_2S_5 yield $(\text{EtO})_2\text{P}(\text{SH})$: S which on hydrolysis yields no EtSH , but only H_2S , water, sulfur, and polythionic acids.

82 **Pollacci, E.** *B.A. 1875*, 131, 336. *Gazz. chim. ital.* 4, 177-9, 245-6. Action of Sulfur on Calcium Carbonate.

Sulfur and calcium carbonate moistened with water will form calcium sulfate. Reaction slow.

83 **Pollacci, E.** *B.A. 1875*, 612. *Gazz. chim. ital.* 4, 469-71. Action of Sulfur on Calcium Carbonate.

See *B.A. 1875*, 336. Action goes faster than first believed. 25 g. showed indications of sulfuric acid in 2 hours. Also found thiosulfate.

84 **Pollacci, M.** *C.A. 1908*, 3204. *Mon. sci.* [4] 22, 373. The Spontaneous Oxidation of Sulfur and of Metallic and Non-Metallic Sulfides.

All sulfides are oxidized by the air even below 30°. Action is accelerated by sun-

light, movement of air and fine pulverization. O_2 is not fixed to form sulfates, the S is set free with the formation of the corresponding oxide. The S thus set free is oxidized to H_2SO_4 which reacts to form sulfates.

85 Powell, A. R., and Parr, S. W. *C. A.* 1920, 112. *Bull. Am. Inst. Mining Met. Eng.* 1919, 2041-9. Forms in which Sulfur Occurs in Coal. Sulfates, inorganic sulfur as pyrites and marcasite. Organic sulfur in 2 forms, resinic and humus.

86 Radziszewski, B., and Sokolowski, A. *B. A.* 1874, 476. *Ber.* 7, 143-5. Action of Sulfur on Barium Benzoate. Tried to check Pfankuch on the action of S on barium benzoate, but did not find tolane or barium sulfate. Found diphenyl, benzene, benzoic acid, benzophenone, a high boiling mercaptan barium sulfide, and carbon.

87 Radziszewski, B. *B. A.* 1875, 1190. *Ber.* 8, 758-9. Action of Sulfur on Dibenzyl. Barium salt of phenylacetic acid heated yields stilbene instead of dibenzyl, due to further action of S.

88 Rehlander, P. *B. A.* 1903, i, 571. *Ber.* 36, 1583-7. Binaphthylene, Thiophene and Trinaphthylenebenzene. Prepared previously to the work of Dziewonski (*B. A.* 1903, i, 431). Extract with xyltne to remove thiophene.

89 Renard, A. *B. A.* 1890, 134. *Compt. rend.* 109, 699-700. Phenylthiophene. Vapors of sulfur and toluene are passed through a dull red tube, hydrogen sulfide and a new phenylthiophene being formed.

90 Renard, A. *B. A.* 1890, 1420. *Compt. rend.* 111, 48-9. Phenylidthienyl. See *B. A.* 1890, 134. Toluene and sulfur at a dull red heat give phenylthiophene and phenylidthienyl. Prepared derivatives.

91 Renard, A. *B. A.* 1891, 427. *Compt. rend.* 112, 49-50. Trithienyl. If sulfur vapor and benzene are passed through a tube at bright redness, there are formed carbon disulfide, hydrogen sulfide, unaltered sulfur and a liquid yielding on distillation benzene and trithienyl. It is not affected by boiling alkaline permanganate or nitric acid. Brom and oxidation products prepared. See abstract.

92 Schmidt, H. *C. A.* 1927, 2785. *Petroleum Z.* 33, 646-8. Corrosion Effect of Sulfur and Sulfur Compounds in Naphtha Solutions. The activity of sulfur compounds on strips of Al, Zn, Fe, Cu, brass and Ag is given. Mercaptans are most corrosive.

93 Schultz, G., and Beyschlag, H. *C. A.* 1909, 1176. *Ber.* 42, 743-52. The Action of Sulfur of m-Tolylene-diamine. The above substances in boiling alcohol give the polysulfide.

94 Schulze, F. *B. A.* 1871, 219. *Ber.* 4, 33. On the Action of Sulfur on Benzene. Sealed tubes containing 1 g. benzene and sulfur in ratio of 2 mol. S to 1 mol. benzene placed in combustion tube and heated to 400°-500° C. for 2 h. in combustion furnace. H_2S formed—little unchanged S and little carbonaceous matter. Long needles formed from EtOH and yellow crystalline crusts having odor of diphenyl and of sulfur compounds.

95 Schutz, E. *C. A.* 1908, 527. *Metallurgie* 4, 659-67. The Affinity of Sulfur for a Series of Metals. Various metals studied. Mixtures investigated were charged into graphite crucibles; for low temperatures heat in a gas furnace, for high temperatures in a Kryptal furnace.

96 Scott, A. *Proc. Chem. Soc.* 1904, 156. Some Alkyl Derivatives of Sulfur, Selenium, and Tellurium. Sulfur and CH_3I heated at 180° form trimethylsulfonium iodide.

97 Solomon, F. *B. A.* 1873, 350. *J. prakt. Chem.* [2] 5, 476-80. Carbon Oxysulfide. Prepared from K sulfocyanate and sulfuric acid. Prepared also by CO_2 and S through red hot tube, absorbed in alcoholic KOH and then liberated by HCl.

98 Stillich, O. *B. A.* 1906, i, 552, 626. *J. prakt. Chem.* [2] 73, 538-44; 74, 51-6. Sulfoacetic Acid. Prepared by heating glacial acetic acid with sulfuric acid—yield dependent upon temperature and amount of water present. See abstract.

99 Szperl, L. *C. A.* 1919, 2865. *Chemik. Polski* 15, 10-8. Action of Sulfur on Organic Compounds. I, Hydrocarbons. A review of the literature on the subject.

100 Szperl, L. *C. A.* 1924, 1290. *Roczniki Chemii* 1923, ii, 291-313. Action of Sulfur on Organic Compounds, VI. A short summary is given of the first 5 parts of present series dealing with action of sulfur on various aromatic compounds. Present paper deals with action of sulfur on α - and β - $C_{10}H_7CH_2OH$. Results similar to those obtained with $PhCH_2OH$.

101 Szperl, L., and Jezierski, T. W. *C. A.* 1924, 1290. *Roczniki Chemii* 3, 177-83. VII. Quinoline and Sulfur. Complex products containing sulfur formed.

102 Szperl, L., and Wydryzcki, S. *C. A.* 1927, 2472. *Roczniki Chemii* 6, 156-64. Action of Sulfur on Organic Compounds. VII, Aromatic Aldehydes. Sulfur acts on aldehydes in sealed tube yielding an acid, a hydrocarbon, and a thiophene derivative, together with other products.

103 Szperl, L. *C. A.* 1927, 3603. *Roczniki Chemii* 6, 728-37. Action of Sulfur on Organic Compounds. Studied reaction with aromatic alcohols, aldehydes, acids.

104 Taboury, B. A. 1903, i, 748. *Bull. soc. chim.* [3] 29, 761-5. Action of Sulfur and of Selenium on Magnesium Phenyl and Magnesium α -Naphthyl Bromides. Sulfur on aryl magnesium bromide yields on decomposition thiophenol and

disulfide. If benzoyl chloride is used for the first decomposition in place of HCl, arylthiobenzoate is formed.

105 Taboury, F. B.A. 1905, i, 56. *Bull. soc. chim.* [3] 31, 1183-8. Mixed Phenolic Sulfides. Prepared from alkyl haloid reacting with the compounds obtained by the interaction of sulfur with magnesium alkyl haloids.

106 Taboury, F. B.A. 1905, i, 644. *Bull. soc. chim.* [3] 33, 836-9. Action of Sulfur on the Organo-magnesium Derivatives of p-Bromoanisole and Phenetole. Prepared thiophenols. H_2O_2 oxidizes these to disulfides. The magnesium compounds react with acetyl chloride to form thioacetates.

107 Taylor, J. B.A. 1883, 824. *Chem. News* 47, 145. Preparation of Hydrogen Sulfide from Coal Gas. H_2S may be prepared very easily, and sufficiently pure for ordinary analytical purposes, by passing coal gas through boiling sulfur.

108 White, G. N. C.A. 1918, 2193. *J. Chem. Soc.* 113, 608-9. Preparation of a New Type of Sulfur Compound. When β -($C_{10}H_7S)_2$, Na_2S and S are heated in molecular amounts, $C_{10}H_7S Na_2S \cdot S$ is formed.

109 Wibaut, J. P. C.A. 1919, 2509. *Rec. trav. chim.* 38, 159-62. The Behavior of Sulfur toward Carbon Compounds at High Temperatures. Various percentages of sulfur were obtained in compounds produced by action of sulfur on carbon compounds at high temperatures.

110 Wood, A. E., Sheely, C., and Trusty, A. W. C.A. 1926, 1784. *Ind. Eng. Chem.* 18, 169-71. Action of Petroleum Refining Agents on Naphtha Solutions of Pure Organic Sulfur Compounds. The effect of H_2SO_4 , $NaPbO_2$, $NaOH$, silica gel, fuller's earth and Al_2O_3 on naphtha solutions of S, H_2S , Me_2SO , CS_2 , Bu_2S , Pr_2S_2 , iso-AmSH, thiophene, Ph_2SO , Bu_2SO_2 and p-MeC₆H₄SO₂Me.

111 Wood, A. E. C.A. 1927, 1540. *Oil and Gas J.* 25, No. 40, 147, 158. Numerous Phases to Sulfur Problem. A study of the action of $NaOCl$, H_2SO_4 , Na_2PbO_2 , $NaOH$, SiO_2 gel, fuller's earth, Al_2O_3 , CuO on naphtha solutions of sulfur and sulfur compounds indicates that none of the agents is effective with all types of sulfur compounds. Merits of each discussed.

112 Wright, C. J. C.A. 1929, 4054. *J. Inst. Petroleum Tech.* 15, 214-44. Methods of Refining Sulfurous Oils. Reagents for removal of various sulfur compounds are given.

113 Wuyts, H. C.A. 1910, 448. *Bull. soc. chim.* [4] 5, 405-12. Action of Sulfur and Selenium on Organo-magnesium Derivatives. When S acts with Mg organic derivatives under various conditions, the corresponding thiol, sulfide, and disulfide are formed. Conditions for formation of these given. Se reacts similarly.

114 Wuyts, H., and Cosyns, G. B.A. 1903, i, 686. *Bull. soc. chim.* [3] 29, 689-93. Action of Sulfur on Organo-magnesium Compounds. When ethyl magnesium iodide is treated with sulfur and the resulting product decomposed with water, H_2S is evolved and ethyl mercaptan and a small amount of ethyl disulfide is formed. Phenyl magnesium bromide and sulfur yield phenyl sulfide as well as the other compounds.

115 Zeiser, F. B.A. 1895, i, 512. *Ber.* 28, 1670-5. Toly Derivatives of Sulfur, Selenium, and Tellurium. Diorthotolyl sulfide is obtained by heating mercury diorthotolyl with sulfur.

116 Ziegler, J. H. B.A. 1890, 1246. *Ber.* 23, 2472-6. Synthesis of Tetraphenyl-thiophene. Action of sulfur and phenylacetic acid for 6 hours at 260°. When sulfur combines with the nucleus, there is a basic group present.

CROSS REFERENCES

Group 1—111, 152.

GROUP 3

HYDROGEN SULFIDE, POLYSULFIDE ACIDS AND SOME OF THEIR REACTIONS WITH ORGANIC COMPOUNDS

1 Alexejeff, W. B.A. 1878, 132. *Ber.* 10, 1739. Action of Hydrogen Sulfide on Propyl Aldehyde. Saturated aqueous solution of propyl aldehyde acidified with hydrochloric acid, with H_2S . On complete saturation obtained heavy liquid with odor of thiopropanaldehydes.

2 Anon. C.A. 1910, 1537. *J. Gas Lighting* 109, 729. Feld's Process for Utilizing Sulfur from Hydrogen Sulfide and Sulfur Dioxide.

Gases containing sulfides or SO_2 came into contact with ZnO forming sulfides or sulfites of Zn. Latter salts then decomposed by H_2S present, forming sulfides and free sulfur, etc.

3 Anon. C.A. 1928, 4771. *Het Gas (The Hague)* 48, 281. Laboratory Apparatus for Control of the Hydrogen Sulfide Content of Gas.

Gas flows through a glycerol wash bottle and a thermometer capillary on a continuously moving strip of filter paper, moistened by a wick with $Pb(OAc)_2$ solution.

4 **Anthony, V., and Magri, G. B.A. 1905, ii, 446.** *Gazz. chim. ital.* **35**, (i) 206-26. Liquid Hydrogen Sulfide as a Solvent.
See abstract for substances studied—hydrocarbons, etc. Liquid H_2S is not chemically active in liquid state.

5 **Apitzsch, H., and Kelber, C. C.A. 1909, 2942.** *Ber.* **42**, 2490-3. Thio- γ -pyrone Derivatives. (VI), Sulfides from α , α' -Disulphydrylthio- γ -pyrone- β , β -dicarboxylic Ester.
The method of formation of these complex sulfides is given. Also action of alkalies, acids, and oxidizing agents.

6 **Bach, H. C.A. 1929, 2273.** *Gas u. Wasserfach* **72**, 154-5. The Determination of Low Percentages of Hydrogen Sulfide in Gas.
See abstract for procedure.

7 **Baumann, E., and Fromm, E. B.A. 1890, 25.** *Ber.* **22**, 2600-9. Thioaldehydes.
Prepare β -trithioaldehyde by passing H_2S into a solution of aldehyde (1 part) alcohol saturated with HCl (3 parts). Forms some α - but mostly β . Prepared β - and γ -thiobenzaldehyde. Oxidized thioaldehydes with potassium permanganate to form trisulfone.

8 **Baumann, E., and Fromm, E. B.A. 1895, i, 362.** *Ber.* **28**, 895-907. Thio-derivatives of Ketones.
In *Ber.* **22**, 1035, 2592 it was shown that acetone and H_2S reacted only in the presence of zinc chloride or HCl. Studied acetophenone in detail. Other ketones also studied.

9 **Baumann, E., and Fromm, E. B.A. 1895, i, 363.** *Ber.* **28**, 907-14. Action of Ammonium Sulfide on Acetophenone.
Acetophenone like benzophenone with ammonium sulfide in alcoholic (65%) solution gives α -phenylethyldisulfide, m. p. 57°-58°. Reduced to mercaptan. Decomposes on distillation to thiophene derivatives.

10 **Berthelot, M. B.A. 1876, ii, 596.** *Bull. soc. chim* [2] **26**, 101-4. Formation and Decomposition of Binary Compounds by the Dark Discharge.
Hydrogen sulfide is resolved into hydrogen sulfur and hydrogen persulfide.

11 **Biltz, H. C.A. 1909, 2306.** *Ber.* **42**, 1792-1800. New Method for the Preparation of Thiohydantoins and their Desulfurization.
Prepared by action of benzil, thiocarbamide and KOH in alc. media. Action with oxidizing agents and alkalies given.

12 **Birch, S. F. C.A. 1929, 4055.** *Oil and Gas J.* **28**, No. 1, 190, 193-4. Hypochlorite Process of Refining.
Preparation of the reagent, treatment of sulfur containing straight-run gasoline, and the application of the process to natural gasoline, cracked gasoline, kerosene, and painter's naphtha given.

13 **Blaikie, J. A. B.A. 1882, 592.** *Proc. Roy. Soc. Edinburgh* **10**, 87-9. Note on the Crystalline Compound Formed in Water Containing Hydrogen Sulfide and Mercaptan.
Crystals formed when H_2S is passed into water saturated with EtSH at 0°. Crystals seem to contain 90% H_2O .

14 **Bloch, I., and Hohn, F. C.A. 1908, 2517.** *Ber.* **41**, 1961-71. On Hydrogen Persulfide I; History, Crude Hydrogen Persulfide.
A historical review of work on hydrogen persulfide from time of Scheele to date given.

15 **Bloch, I., and Hohn, F. C.A. 1908, 2517.** *Ber.* **41**, 1971-5. On Hydrogen Persulfide. II, Hydrotrisulfide.
Preparation and properties of the compound are given. Bright yellow liquid at ordinary temperature. Stable in dark. Combines with Ag_2O with explosive force, forming Ag_2S .

16 **Bloch, I., and Hohn, F. C.A. 1908, 2517.** *Ber.* **41**, 1975-80. On Hydrogen Persulfide. III, Hydrodisulfide.
A procedure for making H_2S_2 and H_2S_3 given. H_2S_2 is clear yellowish liquid, miscible with CS_2 , ether or benzene, and attacks the eyes and mucous membranes. B. p. 74°-75°.

17 **Bloch, I. C.A. 1908, 2518.** *Ber.* **41**, 1980-5. On Hydrogen Persulfide. IV, Constitution of Hydrotrisulfide and Hydrodisulfide and the Chemistry of Sulfur Compounds.
More stable at low temperatures. Also have tendency to form chain compounds at low temperatures.

18 **Bolling, R. C.A. 1907, 2403.** *Eng. News* **58**, 110. A Commercial Method of Testing Producer Gas for Sulfur.
A method for the determination of H_2S and CS_2 in producer gas is described. The sulfur is determined as $BaSO_4$ gravimetrically.

19 **Bossner, F. C.A. 1909, 1455.** *J. Gasbel.* **51**, 777. Contribution to the Dry Purification of Gas—The Elimination of Hydrogen Sulfide.
The relation between volume of gas and the amount of reagent is of first importance. The speed with which gas passes through purifiers, provided these are sufficient, is of no consequence.

20 **Bottinger, C. B.A. 1876, 70.** *Ber.* **9**, 404. Sulfur Compounds of Pyroracemic Acid.
Salt of pyroracemic acid with silver oxide was decomposed by H_2S . Product formed was not identified.

21 **Bottinger, C. B.A. 1879, 451.** *Ber.* **11**, 2203-6. Conversion of Aldehydes into Mercaptans.
Aldehydes and H_2S give thioaldehyde. The solid polymer heated in sealed tubes at 160° with hydriodic acid yields disulfide; with zinc dust and acid form mercaptan.

22 **Bottinger, C. B.A. 1880, 237.** *Ber.* **12**, 1956-8. Decomposition of Mesoxalic Acid by Sulfuretted Hydrogen.
Thioglycolic and dithioglycolic acids are obtained, together with a little oxalic acid, when H_2S is passed for many hours through a dilute solution of mesoxalic acid previously treated with silver oxide.

23 **Brown, F. E., and Snyder, J. E.** *C. A.* 1926, 2481. *J. Am. Chem. Soc.* 48, 1926-8. Formation of Ethyl Mercaptan from Ethyl Iodide in Aqueous Hydrogen Sulfide Solutions and its Bearing on the Mechanism of the Precipitation of Metals by Hydrogen Sulfide.*

24 **Brunner, H., and Vuilleumier, V.** *C. A.* 1908, 3347. *Schweiz. Wochschr.* 46, 436. Action of Hydrogen Persulfide on Organic Compounds. Compounds were prepared with benzaldehyde, anisic and cinnamic aldehydes, benzoquinone and piperidine.

25 **Chabrie, C. B. A.** 1898, i, 9. *Compt. rend. soc. biol.* [10] 3, 72-3. Cystin. H_2S was passed through a mixture of aldehyde ammonia with ether, and a substance $HS \cdot CHMe \cdot NH \cdot CHMe \cdot OH$ was isolated. This is held as confirmatory that cystin may originate during the digestion of proteins by the action of H_2S on the amido-acids.

26 **Chakravarti, G. C.** *C. A.* 1929, 127. *J. Indian Chem. Soc.* 5, 405-10. Thiophthalic Acids. The preparation, properties, and various derivatives are given.

27 **Ciochina, I.** *C. A.* 1927, 2549. *Bul. soc. chim. România* 8, 126-7. Volumetric Determination of Hydrogen Sulfide in Producer Gas.*

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29 **Colombo, C., and Spica, P.** *B. A.* 1875, 894. *Gazz. chim. ital.* 5, 124. On Some Derivatives of Alphatolanic Acid. Alphatolanic sulfamide prepared by passing dry H_2S into alcoholic solution of nitrite. Water added, sulfamide separates. This in alcoholic solution with H_2 from Zn and HCl slowly forms amine hydrochloride.

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31 **Deuss, J. J. B.** *C. A.* 1908, 2552. *Rec. trav. chim.* 27, 145-8. On the Action of Aluminum Chloride on Thiophenol. $AlCl_3$ reacts on thiophenol in ligroin solution, on warming, with liberation of H_2S and some HCl, and formation of phenyl sulfide and phenylene disulfide.

32 **Dibdin, W. J., and Grimwood, R. G.** *B. A.* 1902, ii, 582. *Analyst* 27, 219-23. Detection and Estimation of Minute Quantities of Hydrogen Sulfide in Coal Gas. Use dry lead acetate papers.

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35 **Fischer, E.** *B. A.* 1884, 109. *Ber.* 16, 2234-6. Formation of Methylen-blue as a Reaction for Hydrogen Sulfide. Use a few grains of paramidodimethyl-aniline sulfate to an aqueous solution of H_2S to which has been added one-fiftieth of its volume of concentrated hydrochloric acid. Strong blue color formed on standing.

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39 **Fowler, H. C.** *C. A.* 1928, 1417. *Oil and Gas J.* 26, No. 36, 170, 173-4. Poisoning from Hydrogen Sulfide. General characteristics, physiological action and treatment of H_2S poisoning are discussed.

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41 **Fromm, E., and Ziersch, P.** *C. A.* 1907, 307. *Ber.* 39, 3599-3609. Thio-derivatives of Ketones. Tetrasulfides formed from H_2S , HCl gas and ketone. Action with alkalies, concentrated H_2SO_4 , bromine, methyl iodide, and $KMnO_4$ given.

42 **Fromm, E., and Holler, H.** *C. A.* 1907, 2475. *Ber.* 40, 2978-82. Action of Ammonium Sulfide on Ketones. The solution obtained by saturating absolute EtOH with NH_3 and H_2S is allowed to react on acetophenone. M. 118° product consists of mixture of sulfur and a. β -diphenylthiophene. Sulfur removed by $(NH_4)_2S$.

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Alcoholic benzylideneacetone solution when treated successively with dry NH_3 and H_2S yields duplobenzylidenethioacetone. Latter adds HCl , H_2SO_4 , HBr . Boiling dilute acids form H_2S , benzylideneacetone and duplobenzylidenethioxyacetone.

44 Fromm, E. C.A. 1908, 2789. *Ann. 361*, 302-52. Disulfides with Neighboring Double Bonds. The action of aromatic amines on thiurets are given. The article is long and many compounds are described.

45 Fromm, E. C.A. 1909, 154. *Ber. 41*, 3397-425. The Lowest Oxides of Hydrogen Sulfide. H_2S and H_2SO_2 are the lowest oxides—neither obtained in the free state. All disulfides, inorganic and organic of structure $\text{X: C(R)SSC(R)}_1 : \text{Y}$ with open chain are hydrolyzed by boiling water or alkalies with separation of S. $\text{Na}(\text{C}_2\text{H}_5)\text{S}_2\text{O}_3$ and aromatic disulfides also hydrolyzed but no separation of S. Existence of RSOR indicated.

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59 Latta, Nisbet. C.A. 1909, 1808. *Progressive Age 27*, 390. Organic Sulfur and its Elimination. The Pabst reheating system is successfully used for the elimination of organic S gases at the Portland Oregon Gas Company.

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Dry H_2S and ethyl imido acetate in Et_2O form the thio ester. Acid could not be isolated—very unstable. In Et_2O the thio ester changes gradually to thioacetamide. Ethyl thiopropionate and ethyl thiobenzoate were prepared similarly. Latter yields a thioamide.

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Hydrogen at a known pressure was passed over sulfur at 278° and amount of H_2S formed in given length of time noted. Effect of various catalysts studied.

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See article.

68 Muller, E., and Schiller, G. C. A. 1927, 2872. *J. prakt. Chem.* 116, 175-91. Thioacetaldehyde.
Method of preparation of monothioparaldehyde and α -trithioacetaldehyde given. Also certain derivatives.

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Barium carbonate suspended in water treated with slow stream of H_2S showed deposition of barium sulfide. Magnesium, zinc, and lithium carbonates behaved in same manner.

70 O'Donoghue, I. G., and Kahan, Z. C. A. 1907, 411. *Proc. Chem. Soc.* 22, 273. Thiocarbonic Acid and Some of its Salts.
Heavy red oil, b. p. 50°. When distilled under diminished pressure, yields CS_2 , H_2S and sulfur. Salts are unstable in air and vacuum giving CS_2 and metallic sulfide.

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Gas containing about 30 g. org. sulfur per 100 cu. m. was passed over hot Fe turnings and then washed with $NaOH$. The sulfur was reduced to between 1 and 2%.

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 H_2S from commercial ferrous sulfide has some arsenic. Suggests using calcium sulfide.

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 H_2S forms addition products with $AlBr_3$, $AlBr_2$, and Et_2Br , $AlBr_3$ and $C_6H_4Br_2$, and $AlBr_3$ and $CHBr_2$.

75 Prutzman, P. W. C. A. 1908, 175. *Progressive Age* 25, 577. Sulfur and Oil Gas.
Occurs in gas as H_2S and S compounds of hydrocarbons. At 400° F., a portion is broken down and H_2S results.

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Gives preparation and reactions. Unstable. It is a more powerful reducing agent than hydrogen sulfide.

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A drop of saturated solution of sodium nitroprusside gives an intense violet color with 0.004 cc. of an ammonium sulfide solution containing 0.0000018 g. H_2S . See abstract for details. *B. A.* 1904, II, 514 gives further work on this reaction.

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Authors conclude that I test—in conjunction with qualitative test for H_2S —is very useful method for controlling gas purification by oxide of Fe, but useless for carbureted water gas.

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 SO_2 , H_2S , COS , CS_2 studied.

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Alcohols are converted into mercaptans by conducting their vapors and H_2S over ThO_2 heated to 300°-360°. Yields 50 to 75%. A number were prepared in this way.

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Show that solutions of H_2S in a mixture of glycerol and water (equal parts) proposed by Lepage (*J. Pharm.* 1867) undergoes less change than do those in water (see Lindo *B. A.* 1888, 750). Oxidation of H_2S in solutions of gas proceeds more rapidly in diffused light than in darkness.

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Use of hydrogen persulfides and hypofluorous acid.

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91 Stone, C. H., and Wiig, E. O. C. A. 1923, 2486. *Gas Age-Record* 51, 649-50, 655. Determination of Hydrogen Sulfide.*

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100 Wright, L. T. *J. Chem. Soc. Trans.* 1883, 267-8. On the Estimation of Hydrogen Sulfide and Carbon Dioxide in Coal Gas. See paper.

101 Yant, W. P., and Fowler, H. C. C. A. 1927, 170. *Bur. Mines. Repts. Investigations* 1926, No. 2776, 20 p. Hydrogen Sulfide Poisoning in the Texas Panhandle, Big Lake, Tex., and McComey, Tex., Oil Fields.*

CROSS REFERENCES

Group 1—11, 105, 117, 133; Group 2—17, 29, 33, 46, 50, 51, 65, 70, 81, 91, 92, 98, 107, 110, 111, 112.

GROUP 4

CARBON OXYSULFIDE (COS), FORMATION AND REACTIONS

1 **Bernardi, A., and Rossi, G. C. A.** 1922, 2113. *Gazz. chim. ital.* **52** (1), 139-40. Action of Carbon Disulfide on Mercuric Acetate.
 $S(HgOAc)_2$ was obtained in the reaction. Authors suggest the equation:
 $CS_2 + 2 Hg(OAc)_2 + H_2O = S(HgOAc)_2 + COS + 2 AcOH$

2 **Berthelot, M. B. A.** 1872, 995. *Ann. chim. phys.* [4] **26**, 470-2. Carbon Oxysulfide.
 Studied its reactions. Aqueous KOH, $Br_2 \cdot H_2SO_4$, KOH moistened by alcohol, and abs. EtOH behave same with CS_2 and COS. With ammonia a crystalline derivative is immediately formed, ammonium oxysulphocarbamate. Reactions of this compound studied.

3 **Berthelot, B. A.** 1882, 823. *Compt. rend.* **94**, 1069-70. Conversion of Carbon Oxysulfide into Carbamide and Thiocarbamide.
 Ammonia combines readily with carbon oxysulfide forming oxythiocarbamate which is transformed into carbamide with elimination of hydrogen sulfide.

4 **Berthelot, B. A.** 1884, 728. *Ann. chim. phys.* [5] **30**, 539-41. Reactions of Carbon Oxysulfide.
 Reacts with ammonia to form ammonium sulphocarbamate. Considers isomers possible.

5 **Berthelot, M. P. E. B. A.** 1899, ii, 287. *Ann. chim. phys.* [7] **14**, 205. Reaction of Carbon Oxysulfide.
 Reacts with acid solution of cuprous chloride to form cuprous sulfide, CO_2 , and HCl.

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 Only symmetrical anhydrides of the formula $E:C(R)E'C(R):E'$ are stable. The unsymmetrical compounds readily evolve CO_2 or COS.

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 Author suggests that water first adds and then there is decomposition.

8 **Carnelley, T. B. A.** 1875, 523-6. Note on the Effect of Passing the Mixed Vapors of Carbon Disulfide and Alcohol over Red Hot Copper.
 Decomposes carbon disulfide to carbon oxysulfide.

9 **Fleischer, A. B. A.** 1878, 29. *Ber.* **10**, 1293. Distillation Products of Xanthates (Ethyl Dithiocarbonates).
 Sodium and potassium xanthates yield the same distillation products, *i. e.*, carbon disulfide, mono and disulfides of ethyl, and carbon oxysulfide when anhydrous salts were used; and mercaptan, carbon disulfides, alcohol, the two ethyl sulfides, car-

bonic acid, and hydrogen sulfide when salts containing water of crystallization were employed. See abstract or paper.

10 **Gautier, A. B. A.** 1889, 212. *Compt. rend.* **107**, 911-3. Formation of Carbon Oxysulfide by the Action of Carbon Disulfide on Clay.
 Kaolin heated to bright redness and then CS_2 passed through it formed 60 to 64% COS. 35-39% CO and 1% CO_2 . Properties of COS studied.

11 **Hempel, W. B. A.** 1901, ii, 651. *Z. angew. Chem.* **14**, 865-8. Carbon Oxysulfide.
 Decomposes readily in presence of moisture. Best stored in liquid state. Pure has faint odor but acts quickly on the nervous system. Boils at -47.5° at atmospheric pressure. See abstract.

12 **Johnson, T. B., and Levy, L. H. C. A.** 1908, 82. *Am. Chem. J.* **38**, 456-61. Researches on the Thiocyanates and Isothiocyanates: Diphenylthiocyanate. The latter was prepared when diphenylcarbamyl thiocyanate was heated with thiobenzoic acid. Carbonyl sulfide also formed.

13 **Kern, S. B. A.** 1876, ii, 477. *Chem. News* **33**, 253. Production of Carbon Monosulfide.
 Iron wire digested 6 weeks in carbon disulfide completely reduced it to carbon monosulfide, a reddish brown powder, upon dissolving the iron disulfide in HCl.

14 **Klason, P. B. A.** 1887, 1015. *J. prakt. Chem.* [2] **36**, 64-74. Preparation and Properties of Carbon Oxysulfide.
 Prepared from thiocyanates. See abstract.

15 **Klason, P. B. A.** 1887, 1029. *Ber.* **20**, 2384-5. Thio-derivatives of Ethyl Carbonate.
 Studied the reactions of thiophosgene with alcohol to form COS and some $C \cdot SCI \cdot OEt$.

16 **Markownikoff, W. B. B. A.** 1904, i, 383. *J. Russ. Phys. Chem. Soc.* **35**, 1049-72. Structure of Heptanaphthalenes and some of their Compounds.
 The xanthic ester decomposes into COS, CH_3SH and an unsaturated hydrocarbon C_7H_{12} .

17 **Nuricsan, J. B. A.** 1892, 15. *Ber.* **24**, 2967-74. New Method of Preparing Carbon Oxysulfide.
 Pass dry carbonyl chloride over finely pulverized cadmium sulfide. Favorable temperature is 260° - 280° . Gas contains 94.87% COS, 3.98% CO and air, 1.15%.

18 **Pinner, A., and Schaumann, W. B. A.** 1881, 811. *Ber.* **14**, 1082-3. Action of Hydrochloric Acid Gas on Thiocarbamides and Thiocyanic Ethers in Presence of Absolute Alcohol.
 Absolute alcohol and phenyl thiocarbamide saturated with HCl gives slowly

aniline and carbon oxysulfide. Ethyl thiocyanate and alcohol saturated with HCl gives isothiocurethane. This splits up into mercaptan and cyanuric acid in sealed tubes at 150°.

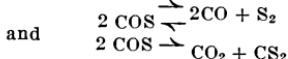
19 Schmidt, E. *B.A.* 1877, ii, 307. *Ber.* 10, 191-3. Action of Carbon Oxysulfide on Aqueous Ammonia.

Forms ammonium oxysulphocarbamate.

20 Sidot, L. *B.A.* 1875, 1236. *Compt. rend.* 131, 32-4. Carbon Monosulfide. Gives preparation and properties.

21 Stock, A., and Seelig, P. *C.A.* 1920, 27. *Ber.* 52, 681-94. Decomposition of Carbon Oxysulfide when Heated.

Two equil. seem to be involved.



22 Tschugaeff, L. *B.A.* 1900, i, 129. *Ber.* 32, 332-5. New Method of Preparing Unsaturated Hydrocarbons.

When an alkyl xanthate of the unsaturated hydrocarbon radical is dry distilled, it decomposes giving carbon disulfide, COS, ROH and RSH and the unsaturated hydrocarbon. See abstract for uses.

23 Tschugaeff, L. A. *B.A.* 1904, i, 327. *J. Russ. Phys. Chem. Soc.* 35, 1116-79. Derivatives of Menthylxanthic Acid and Menthenes from Different Sources.

Methylmentylxanthate on dry distillation gives $\text{C}_{10}\text{H}_{18}$, methyl mercaptan, and carbon oxysulfide. See abstract for details.

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Alkyl magnesium bromide and carbonyl sulfide react to give thioacids and s-tri-substituted carbinols in varying proportions.

CROSS REFERENCES

Group 2—97; Group 3—79, 92.

GROUP 5

CARBON DISULFIDE (CS_2) AND CARBON MONOSULFIDE (CS)

1 Allary, E. *B.A.* 1881, 800. *Bull. soc. chim.* [2] 35, 491-2. Purification of Carbon Disulfide.

Use permanganate until permanent pink color appears.

2 Anon. *C.A.* 1908, 1338. *J. Gasbel.* 51, 121. Amount of Carbon Disulfide in Illuminating Gas from Vertical Retorts. Communication from the Imperial Continental Gas Association and Deutsche Kontinental Gas Gesellschaft.

Amounts of CS_2 in illuminating gas obtained by carbonization of coals of different sources in vertical and horizontal retorts show the vertical retorts give lower concentration of CS_2 in gas.

3 Anon. *C.A.* 1912, 1223. *J. Gas. Lighting* 117, 222. Sulfur Compounds in Benzol.

Article deals with the estimation of CS_2 , $\text{C}_4\text{H}_8\text{S}$, and mercaptans in benzol products and some experiments for their elimination by use of H_2O_2 , O_3 and PbO_2 as compared with present H_2SO_4 treatment.

4 Anon. *C.A.* 1912, 3006. *J. Gas Lighting* 119, 562. Extraction of Carbon Disulfide from Coal Gas.

Alkali cellulose mixed or not mixed with lime is at ordinary temperature and in state of great dilution an effective and economical absorbent.

5 Arctowski, H. *B.A.* 1894, ii, 315. *Z. anorg. Chem.* 6, 255-9. Some Properties of Carbon Disulfide.

Tested solubility of various inorganic salts. Purified solvent by shaking with mercury until almost free from odor (Sidot's method).

6 Arctowski, H. *B.A.* 1894, ii, 377. *Z. anorg. Chem.* 6, 392-410. Solubility of Iodine in Carbon Disulfide: Nature of Solution.*

7 Arctowski, H. *B.A.* 1895, ii, 308. *Z. anorg. Chem.* 6, 260-7. Solubility of Mercuric Haloids in Carbon Disulfide. Solubility of mercuric chloride, bromide, and iodide studied between -10° to $+30^\circ$ to see if definite compounds are formed. None indicated.

8 Arctowski, H. *B.A.* 1895, ii, 312. *Z. anorg. Chem.* 8, 314-7. Action of Heat on Carbon Disulfide.

Studied decomposition which takes place when CS_2 is distilled through a glass tube heated to 600° . Black lustrous mirror on glass tube containing some sulfur. Also carbon sesquisulfide (see v. Lengyel *B.A.* 1894, ii, 90) is supposed to be formed.

9 Arctowski, H. *B.A.* 1895, ii, 489. *Compt. rend.* 121, 123-5. Solubility of Carbon Compounds in Carbon Disulfide at Low Temperatures.

Solubilities of hydrocarbons at temperature of -77.5°C . to -115°C . are up to 1.9 g. per 100 g. solution. Several hydrocarbons studied.

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Shows formation of a hydrate $2\text{CS}_2 + \text{H}_2\text{O}$.

11 Bamberger, E., and Lodter, W. *B.A.* 1890, 517. *Ber.* 23, 213-5. Action of Carbon Disulfide on Menthol and Borneol.

Formed xanthic acids from menthol and borneol with carbon disulfide.

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20 Braun, O. *B. A.* 1876, i, 978. *Chem. Zentr.* 1875, 810-5. The Present State of the Disulfide of Carbon Industry. Gives description of apparatus.

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33 **Delachamal** and **Mermet**. *B. A. 1876*, i, 108. *Compt. rend.* **81**, 92-5. Estimation of Carbon Disulfide in Commercial Alkaline Sulfocarbonates. Add lead acetate to decompose sulfocarbonate. Heat to drive off CS_2 . CS_2 is absorbed in olive oil.

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35 **Deninger**, *A. B. A. 1895*, ii, 222. *J. prakt. Chem.* [2] **57**, 346-9. Carbon Monosulfide. Gives method of preparation from sodium in aniline and carbon disulfide in hydrogen atmosphere. Gives some of its properties.

36 **Dewar**, *J.*, and **Jones**, *H. O. C. A. 1910*, 2074. *Proc. Roy. Soc. (Lon.) (A)* **83**, 408-14. Note on Carbon Monosulfide. Reaction given for its preparation. If heated above 360° it yields CS_2 , but not quantitatively.

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38 **Eiloart**, *A. B. A. 1886*, 16. *Chem. News* **52**, 183-4. Reactions with Carbonic Anhydride, Carbon Disulfide and Sulfurous Anhydride. CO_2 and CS_2 passed over Cu, heated to redness. Almost pure CO_2 is evolved.

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42 **Fetkenheuer**, *B.*, and *H.*, and **Lecus**, *H. C. A. 1928*, 1135. *Ber. 60B*, 2528-37. Action of Sodium Amalgam on Carbon Disulfide.*

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44 **Freund**, *E. C. A. 1919*, 2526. *Ber. 52B*, 542-4. Action of Carbon Disulfide on Nitromethane. 40 g. MeNO_2 and 60 cc. CS_2 in 100 cc. absolute alcohol are slowly treated with a concentrated alcoholic solution of 80 g. KOH at 35° . After $\frac{1}{2}$ hour, there is obtained 55% of dipotassium dithioacetate, $\text{KON}(\text{:O}): \text{CHCS}_2\text{K}$, which decomposes at 203.5° on slow heating.

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46 **Griffiths**, *G. C. A. 1925*, 3365. *Gas J.* **169**, 611-3. Carbon Disulfide in Coal Gas. Its Formation and Elimination. Theories for the mechanism of the formation of CS_2 in gas manufacture are reviewed.

47 **Guillet**, *M. C. A. 1913*, 3015. *J. Gas Lighting* **122**, 1010. Decomposition of Carbon Disulfide in Lighting Gas by Heat Purification.*

48 **Guillet**, *O. C. A. 1912*, 2835. *Genie civil* **61**, 184. Elimination of Carbon Disulfide from Gas.*

49 **Harding**, *E. P.*, and **Doran**, *J. C. A. 1908*, 43. *J. Am. Chem. Soc.* **29**, 1476-80. Quantitative Determination of Carbon Disulfide in a Mixture of Benzene and Carbon Disulfide. A review of the literature on the subject is given. The CS_2 is converted into the xanthate, the latter extracted from the C_6H_6 solution, acidified, standard CuAc_2 solution added, and excess acetate determined.

50 **Harding**, *E. P.*, and **Doran**, *J. C. A. 1908*, 245. *J. Am. Chem. Soc.* **29**, 1480-2. The Technical Determination of Carbon Disulfide in Illuminating Gas. Gas passed from meter through KOH , then through concentrated sulfuric acid, and finally into KOH in abs. alcohol. An excess of CuAc_2 added and the excess determined.

51 **Hell**, *C.*, and **Muhlhauser**, *O. B. A. 1878*, 401. *Ber. 11*, 241-6. Catalytic Action of Carbon Disulfide on Mixture of Bromine and Acetic or Formic Acid. Continuing *Ber. 10*, 2102.

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53 **Hlasiwetz, H., and Kachler, J.** *B.A. 1873*, 628. *Ann. Chem. Pharm.* **166**, 137-45. New Derivatives of Sulfo-carbamic Acid.
Ketones and aldehydes form with ammonia and CS_2 peculiar crystallized compounds. Studied condensation of CS_2 and NH_3 .

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References are given to recent literature concerning: detection and estimation of CS_2 ; CS_2 in gas making; removal of CS_2 ; production of CS_2 ; and the equil. between C and S in the formation of CS_2 .

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Benzyl magnesium chloride and CS_2 yield dithiophenylacetic acid.

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These acids were prepared by action of CS_2 on the corresponding alkyl bromide. All are colored, have offensive odors, form salts some of which are unstable.

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Experiments and apparatus are described in detail.

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See article.

59 **Huff, W. J.** *C.A. 1929*, 4047. *Proc. 2nd Intern. Conference Bituminous Coal* **2**, 814-25. Some Phases of the Organic Sulfur Problem in the Manufacture and Utilization of Gas.
 CS_2 , RSH , RSSR , thiophenethene, thiophenene-2-methyl, thiophene, methyl thiophene and diphenylene sulfide have been identified in tar oils, and may be present in gas.

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Methane is synthesized when a mixture of phosphonium iodide and carbon disulfide is heated at 120° - 140° in a sealed tube from which oxygen had been expelled.

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Obtained by action of CS_2 on phenolic compound in presence of anhydrous AlCl_3 .

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Read abstract for various reactions studied, or better see the original. Cyanides, thioamides, and reactions with CS_2 were studied.

63 **Keates, T. W.** *B.A. 1877*, **i**, 236. *Chem. News* **24**, 245-6. Mode of Generating Sulfurous Acid for Use as a Disinfectant.
Burned carbon disulfide in spirit lamp.

64 **Kern, S.** *B.A. 1876*, **i**, 188. *Chem. News* **32**, 163. Purification of Carbon Disulfide.
Liquid mixed with lead nitrate and a little metallic lead.

65 **Knoevenagel, C. A.** *1913*, 4059. *J. Gasbel.* **56**, 757-60. The Removal of Carbon Disulfide from Gases.*

66 **Konowaloff, M. I.** *B.A. 1899*, **i**, 470. *J. Russ. Chem. Soc.* **30**, 12-22. *Chem. Zentr.* **1898**, **ii**, 361-2. Thio-derivatives Obtained by the Action of Aluminum Haloids on Organic Compounds. Synthesis of Thiocarbonates.
 AlBr_3 , CS_2 and $\text{C}_2\text{H}_4\text{Br}_2$ form a heavy oil which crystallizes on standing. This compound reacts with water forming ethylenic thiocarbonate. Ethyl bromide or other bromides give similar compounds, except amyl bromide which liberates HBr . AlCl_3 and EtCl , or AlI_3 and EtI , combine with CS_2 more slowly.

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Death due to paralysis of the respiratory center, not change in blood pigment.

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Some affinity coefficients for bases containing sulfur as thiohydantoin and CH_2CNH are given.

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Pure dry carbon disulfide boiled in reflux apparatus, the vapor being exposed to an electric arc maintained between two carbon poles, darkens apparatus and turns cherry red in color. Great irritation to eyes, and on all mucous membranes. Deep red liquid, tricarbon disulfide. Properties studied.

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The use of sulfur chloride in forming a vulcanized compound with petroleum Jellies is described. The m. p. of the product is 20° to 40° higher than that of the petroleum jelly used.

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77 Matwin, J. *C. A.* 1911, 1989. *J. Gasbel.* 52, 602-4. Removing Carbon Disulfide from Gas. May be removed either by decomposition or absorption. By passing gas over finely divided Ni at 300°, CS_2 decomposes. In this way content of CS_2 is brought from 100 g. to 20 g. per 100 cu. m. Absorption may take place in three ways. These are given.

78 Mercier, M. *B. A.* 1877, ii, 419. *Compt. rend.* 134, 916-7. A Process of Solidification of Carbon Disulfide. Use boiled linseed oil with sulfur chloride and some carbon disulfide to get a gelatinous mass. Evolves carbon disulfide slowly.

79 Merz, V., and Weith, W. *B. A.* 1871, 238. *Z. f. Chem.* (2) 7, 45. On Amido-benzoic Acid and Carbon Disulfide. Amidobenzoic acid and CS_2 in alcoholic solution give H_2S and dicarboxylsulfocarbonilide. The sulfur in this compound is so loosely combined that it is taken out by several oxides at the common temperature.

80 Meyer, V. *B. A.* 1895, i, 77. *Ber.* 27, 3160-1. Formation of Dicarbon Compounds from Carbon Disulfide at Low Temperatures. When CS_2 is chlorinated at 20°-40°, the carbon tetrachloride contains some perchlorethane and perchlorethylene.

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83 Nasini, R., and Scala, A. *B. A.* 1887, 1088. *Gazz. chim. ital.* 17, 236-40. So-called Allyl Trisulfide. Ethyl iodide and CS_2 with sodium amalgam and moisture give product, $\text{C}_5\text{H}_{10}\text{S}_3$, probably from the decomposition of diethyl trithiocarbonate.

84 Paal, C., and Laudenheimer, E. *B. A.* 1893, i, 25. *Ber.* 25, 2978-80. Action of Carbon Disulfide on Orthamidobenzyl Alcohol. CS_2 boiled with orthamidobenzyl alcohol in alcoholic solution. Reaction takes place with loss of H_2S . Formula given, m. p. 142°. Calls it thiocumazone.

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86 Plotnikoff, W. A. *B. A.* 1903, i, 137. *J. Russ. Phys. Chem. Soc.* 34, 697-706. Compounds of Aluminum Bromide with Bromine, Ethyl Bromide, and Carbon Disulfide. Formation of compounds of the type, $\text{AlBr}_3 \cdot \text{Br}_2 \cdot \text{EtBr} \cdot \text{CS}_2$, which on decomposition forms $\text{CBr}_2(\text{SEt})_2$ and CSBr_4 .

87 Rathke, B. *B. A.* 1873, 262-3. *Ber.* 5, 798-9. Perchlorinated Methyl Mercaptan and Action of Carbonsulfochloride and Perchlorinated Methyl Mercaptan on Aniline. Studies action of dry Cl_2 on CS_2 .

88 Riche, A., and Bardy, C. *B. A.* 1875, 669. *Compt. rend.* 130, 238-41. On the Sulfur and Other Flames Utilizable in Photography. See *B. A.* 1875, 294. Lamp consists of nitrogen dioxide going into carbon disulfide.

89 Saccardi, P. *C. A.* 1927, 3578. *Giorn. chim. ind. applicata* 8, 315-6. Sensitive Test for Carbon Disulfide. When boiled with a liquid containing as little as 1 part of CS_2 in 1,600,000, a reagent composed of a C_6H_5 solution of Pb plaster mixed with alcoholic KOH solution gives a black coloration.

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91 Schiff, R. *B. A.* 1885, 717-21. *Gazz. chim. ital.* 14, 368-447. Constants of Capillarity of Liquids. Continuation of previous work (*B. A.* 1884, 808). Among compounds studied were ethyl sulfide, carbon disulfide, and several thiocyanates and thiocarbamides.

92 **Schiff, H. B. A.** 1877, i, 124. *Ber.* **9**, 828. Carbon Disulfide as an Antiseptic. Had kept biological specimens in atmosphere of carbon disulfide for years.

93 **Schmitz-Dumont, W. B. A.** 1898, ii, 140. *Chem. Ztg.* **21**, 487-8, 510, 11. Estimation of Carbon Disulfide in Alcohol, Carbon Tetrachloride, Etc. Purification of Carbon Tetrachloride and a New Compound of the Same. See abstract for method suggested. Dependent upon oxidation to sulfuric acid.

94 **Schutzenberger, P. B. A.** 1891, 19. *Comp. rend.* **111**, 391-3. Platinum Thiocarbide. Forms Pt_2CS_2 which is not attacked by boiling concentrated nitric or hydrochloric acids. Burns in dry O_2 to give a residue of pure platinum. Recommends for use in separation of CS_2 from gas if no oxygen is present.

95 **Schwalbe, C. B. A.** 1905, i, 124. *Z. Farb. Text. Ind.* **3**, 461-4. Preparation of Benzene Free from Sulfur. Carbon disulfide removed by passing ammonia through the hydrocarbon and subsequently washing with dilute sulfuric acid. Thiophene is most completely removed by passing nitrous fumes from sodium nitrite and sulfuric acid through the liquid and subsequently shaking it 2 or 3 times with concentrated sulfuric acid. Shaking with sulfuric acid containing nitrous fumes is not so advantageous.

96 **Selivanoff, T. B. A.** 1893, i, 458. *J. Rus. Chem. Soc.* **24**, 333-4. Trichloromethanesulfonic Chloride. CS_2 and Cl_2 gives $\text{CCl}_3\text{SO}_2\text{Cl}$, which author claims to be mixed anhydride of the sulfinic acid and hypochlorous acid. Can be reduced to sulfinic acid. The chloride liberates 1 mol. of iodide from KI . Chem. reactions given.

97 **Sestini, F. B. A.** 1871, 1023, 1090. *Gazz. chim. ital.* **1**, 473, 475. Reactions of Carbon Disulfide. Takes up solubility in water. With alkalies there is formation of sulfocarbamate with crystals of formula $3 \text{Ca}(\text{OH})_2 \cdot \text{CaCS}_2 \cdot 7\text{H}_2\text{O}$. In second article recommends $\text{Ca}(\text{OH})_2$ as qualitative reagent for CS_2 .

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99 **Speilmann, P. E., and Jones, F. B. C. A.** 1919, 3108. *J. Soc. Chem. Ind.* **38**, 185-8T. Estimation of Carbon Disulfide. A Critical Examination of the Various Methods Usually Employed. The methods are discussed.

100 **Stock, A., and Praeterius, P. C. A.** 1913, 2022. *Gas World*, **58**, 555. Subsulfide of Carbon. Analog of C_2O_3 . Bright red liquid of high refractive power and penetrating odor. Polymerizes in a few minutes at 100° into black coal-like solid.

101 **Thorpe, T. F. J. Chem. Soc. Trans.** 1889, 220-3. The Decomposition of Carbon Disulfide by Shock (A Lecture Experiment). Discusses various sulfides of carbon. Shows how to explode it with small amount of fulminate of mercury.

102 **Tivoli, D. B. A.** 1893, i, 206. *Gazz. chim. ital.* **22**, ii, 379-86. Phenylanilcyanamide and β -Diphenylsemithiocarbazide. β -Diphenylsemithiocarbazide is obtained by the action of ammonium sulfide on phenylanilcyanamide in alcoholic solution.

103 **Walker, D. B. A.** 1874, 1135. *Chem. News* **30**, 28. Action of Carbon Disulfide on the Hydrates of Calcium, Barium, Magnesium, and Zinc. $\text{Ca}(\text{OH})_2$ agitated with CS_2 yields bright orange needles, $\text{CaCS}_2 \cdot 2\text{Ca}(\text{OH})_2 \cdot 6\text{H}_2\text{O}$. On addition of acids, H_2CS_2 formed as oily drops. Ba and Mg form corresponding salts. Zinc is not acted upon by CS_2 .

104 **Walther, R. C. A.** 1907, 1849. *J. prakt. Chem.* **75**, 187-99. The Action of Bromacetophenone on Thiourea. Ring sulfur compounds are formed, (thiazolines). CS_2 converts them into thiothiazolines.

105 **Wanner, H. C. A.** 1916, 683. *J. Gasbel.* **58**, 456-7. Experiments on the Removal of Carbon Disulfide from Illuminating Gas.*

106 **Wartza, A. B. A.** 1871, 307. *Ber.* **4**, 180, 221. Remarks on Ballo's Supposed Hydrate of Carbon Bisulfide. Meets Ballo's criticism and thinks Ballo has no hydrate of carbon disulfide.

107 **Wenzel, G. B. A.** 1901, i, 402. *Ber.* **34**, 1043-50. Action of Halogens and Carbon Disulfide on Sodium Methylen Compounds. Ring formed of 4 carbons and sulfur. Complex compounds.

108 **Wertheim, E. C. A.** 1924, 662. *Science*, **58**, 494. Reactions of Carbon Disulfides with Aldehydes. Preliminary notes without data of research on the condensation of CS_2 with compounds containing the groups $-\text{CH}:\text{O}$ or $-\text{C}(\text{O})\text{CH} =$ to form dithio acid derivatives.

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Group 1—34, 65, 136, 154; **Group 2**—23, 29, 30, 37, 51, 60, 63, 65, 70, 77, 83, 91, 110; **Group 3**—15, 18, 52, 70, 71, 79, 90, 92; **Group 4**—1, 8, 9, 10, 21, 22.

GROUP 6

SULFUR DIOXIDE AS A SOLVENT AND REACTIONS WITH ORGANIC COMPOUNDS

1 **Anon.** *C. A.* 1923, 338. *Refiner Natural Gasoline Mfr.* 1, No. 2, 22-6. Use of Sulfur Dioxide in Treating Oils. Numerous charts given showing solubility of various hydrocarbons in liquid SO_2 .

2 **Berge, A.** *B. A.* 1898, i, 229. *Z. Spiritusind.* 1897, 206; see *Biedermann's Zentr.* 26, 863. The Conversion of Starch by Means of Sulfur Dioxide and Sulfurous Acid. Liquid SO_2 converts dry starch into soluble starch. See abstract.

3 **Brandt, R. L.** *C. A.* 1929, 3337. *Oil and Gas J.* 27, No. 42, 119, 167, 268, 270. Liquid Sulfur Dioxide in Refining. The Edeleanu process as applied to lubricating oils, kerosene, and engine distillate is described.

4 **Cadman, J. C. A.** 1925, 2559. *Petroleum World (Lon.)* 22, 265-71. The Refining of Petroleum in South Wales. Analysis of Persian crude oil is given together with methods of refining.

5 **Carli, F. de.** *C. A.* 1927, 738. *Attaccad. Lincei* [6] 4, 460-6. Addition Products of Sulfur Dioxide and Aromatic Hydrocarbons.*

6 **Cattaneo, G.** *C. A.* 1929, 1742. *Petroleum Z.* 24, 1634-41. Edeleanu Process for Refining Mineral Oils. A general article on the Edeleanu SO_2 process for treating mineral oils.

7 **Colby, C. E., and McLoughlin, C. S.** *B. A.* 1887, 371. *Ber.* 20, 195-8. Action of Sulfurous Anhydride on Benzene. AlCl_3 and benzene and SO_2 form diphenyl sulfoxide, oxidized to sulfone. Can prepare sulfoxide by thionyl chloride in place of sulfur dioxide.

8 **Dott, D. B., and Dougal, J. W.** *C. A.* 1910, 1903. *Pharm. J.* 81, 834. Sulfur Compounds in Coal Gas. Injury to leather upholstery evidently due to combustion products of gas. Damage attributed to sulfuric acid. Tests of the gas indicated presence of SO_2 .

9 **Edeleanu, L.** *C. A.* 1927, 2182. *Mon. pétrole roumain* 25, 2071-8. New Method of Refining Petroleum by Liquid Sulfur Dioxide. The developments in the use of liquid SO_2 in the refining of petroleum are discussed.

10 **Erdely, A., and Almasi, L.** *C. A.* 1928, 3039. *Brennstoff-Chem.* 8, 358-60. Treatment of Benzene Obtained by Cracking Processes and Low Temperature Carbonization with Sulfuric Acid and with Liquid Sulfur Dioxide.*

11 **Fontein, F.** *C. A.* 1923, 1545. *Z. angew. Chem.* 36, 4-6. Miscibility of Hydrocarbons and Liquid Sulfur Dioxide.*

12 **Frankland, E., and Lawrence, A.** *J. Chem. Soc. Trans.* 1879, 244-9. On Plumbic Tetraethide. Lead tetraethyl and sulfur dioxide gave diethyl sulfone and lead ethyl sulfinate.

13 **Cattermann, L.** *B. A.* 1899, i, 516. *Ber.* 32, 1136-59. Replacement of the Diazo Group by the Sulfinic Radical. Gives preparation of aromatic sulfinic acids by saturating diazo salt with SO_2 and then adding copper powder. Aromatic compounds studied having side groups of various types.

14 **Ginsberg, I.** *C. A.* 1926, 1319. *Refiner Natural Gasoline Mfr.* 4, No. 11. 16. Sulfurous Acid as a Refining Agent. SO_2 dissolves a greater part of the aromatic compounds of light oil, but it is best to subject the oil to further treatment with a small quantity of sulfuric acid or oleum.

15 **Guiselin, A.** *C. A.* 1928, 159. *Mon. pétrole roumain* 25, 208-11. The Edeleanu Process, Roumanian Petroleum, and Antidetonants. The value of the process is discussed.

16 **Gutmann, A.** *C. A.* 1909, 894. *Ber.* 42, 228-32. Action of Acids on Sodium Ethyl Thiosulfate. III. Potassium ethyl thiosulfate when heated with H_3PO_4 gives H_2SO_4 , EtSH , diethyl disulfide and SO_2 . Sodium salt behaves similarly.

17 **Haymann, F. H.** *B. A.* 1889, 487. *Monatsh.* 9, 1055-66. Action of Sulfurous Anhydride on Tiglic Aldehyde. Compare *B. A.* 1883, 570 and 1889, 121. Formation of sulfonic acids.

18 **Houben, J., and Arnold, H. R.** *C. A.* 1908, 399. *Ber.* 40, 4306-10. Chloromethyl Sulfate. With SO_2 forms monochlorodimethyl sulfate. Stable in air. Water decomposes it forming MeHSO_3 , HCl , and CH_2O . Highly reactive and permits the introduction into organic compounds of the group CH_2Cl .

19 **Johnston, C. W.** *C. A.* 1928, 2800. *Refrigerating Eng.* 15, 61-71. Sulfur Dioxide. Complete description of a manufacturing plant. The methods of analysis, purification, effect on the human body, and special properties are discussed.

20 **Joseph, T.** *C. A.* 1919, 1922. *Trans. Utah. Acad. Sc.* 1, 214-5. The Liquid Sulfur Dioxide Method of Determining Aromatic Hydrocarbon Oils.*

21 **Kan, T.** *C. A.* 1927, 1344. *J. Soc. Chem. Ind. (Japan)* 30, 129-35. Refining of Cracked Oil. Various refining agents studied.

22 **Klason, P.** *B. A.* 1898, i, 398. *Svensk Kem. Tid.* 9, 135-8. See also *Biedermann's Zentr.* 27, 138. Theory of the Sulfite Process and the Constitution of Lignin. Sulfonic acids formed.

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The fixation of sodium hydrogen sulfite by an ethylene linking generally depends largely upon the character of the molecule. Experimental evidence given.

24 Lazar, A. *C.A.* 1925, 2270. *Asphalt u. Teerind. Ztg.* 25, No. 14a, 28-30. Liquid Sulfur Dioxide.
Results obtained by treating various tar and shale oil distillates with liquid SO_2 are tabulated.

25 Ludwig, E. *B.A.* 1889, 121. *Monatsh.* 9, 658-74. Action of Sulfurous Acid on Methylethylacraldehyde.
Forms on heating at 80° for 4 hours a disulfonic acid. See abstract.

26 McGavack, J., and Patrick, W. A. *C.A.* 1920, 1776. *J. Am. Chem. Soc.* 42, 946-78. The Adsorption of Sulfur Dioxide by the Gel of Silicic Acid.
Adsorption was determined at -80°, -54°, -34.4°, 0°, 30°, 40°, 57°, 80° and 100°. Adsorption isotherms given.

27 Moore, R. J., Morrell, J. C., and Egloff, G. *C.A.* 1918, 1923. *Met. Chem. Eng.* 18, 396-402. The Solubilities of Paraffins, Aromatics, Naphthenes and Olefins in Liquid Sulfur Dioxide.*

28 Neumann, B. *C.A.* 1929, 1254. *Chem. Fabrik* 1928, 641-4. The Edeleanu Refining Process in the Large Plant.
A very complete description is given of the Edeleanu process of treating petroleum distillate with liquid SO_2 with diagrams and photostats.

29 Plank, R. *C.A.* 1929, 2287. *Natl. Petroleum News* 20, No. 46, 63-6, 68, 70-1. Edeleanu Sulfur Dioxide Process used in Treating Lubricating Oils.*

30 Ramzin, L. K. *C.A.* 1928, 4770. *Izvestiya Teplotekhn. Inst.* 1926, No. 1, 51-5. Absorption of Sulfur Dioxide in the Orsat Apparatus.*

31 Rosenheim, A., and Singer, L. *B.A.* 1904, i, 567. *Ber.* 37, 2152-4. Preparation of Alkylsulfinic Acids.
Prepared by the action of sulfur dioxide on ethereal solution of magnesium alkyl halides.

32 Schall, C., and Uhl, J. *B.A.* 1892, 1076. *Ber.* 25, 1875-1901. Action of Iodoform on the Additive Product Obtained from Sulfurous Anhydride and Sodium Phenoxide.*

33 Schall, C. *B.A.* 1894, i, 36. *J. prakt. Chem.* [2] 48, 241-53. Action of Sulfur Dioxide on Sodium Phenoxide.
When SO_2 is passed over sodium phenoxide at the ordinary temperature, the salt is not the analogue of Kolbe's sodium phenylcarbonate but the phenyl salt of sodium sulfonic acid. See abstract for compounds studied.

34 Smythe, J. A., and Forster, A. *C.A.* 1910, 2938. *J. Chem. Soc.* 97, 1195-1200. Some Reactions of Benzyl Mercaptan, Benzyl Tri- and Tetra-sulfides.
After passing SO_2 and HCl gases into BzSH in glacial AcOH at intervals for several days, benzyl disulfide and trisulfide result. Latter gives an additive Ag salt. S_2Cl_2 and BzSH give benzyl tetrasulfide. BzSH and benzyl sulfoxide give the disulfide.

35 Tasker, H. S., and Jones, H. O. *C.A.* 1910, 1023. *J. Chem. Soc.* 95, 1910-8. Actions of Mercaptans on Acid Chlorides. II, Acid Chlorides of Phosphorus. Sulfur and Nitrogen.
 PhSH and SO_2Cl_2 give R_2S_2 , SO_2 and HCl . SOCl_2 reacts two ways on PhSH : in one way, HCl , SO_2 , $(\text{PhS})_2$ and Ph_2S_4 are formed; in another way, HCl , H_2O , $(\text{PhS})_2$ and $(\text{Ph})_2\text{S}_3$ are formed.

36 Tiemann, F. *B.A.* 1899, i, 247. *Ber.* 31, 3297-3324. Hydrosulfonic Acid Derivatives of Cinnamaldehyde, of Citronellal and of Citral.
Addition of sulfurous acid to an unsaturated compound takes place more readily when a normal instead of an acid sulfite is employed, provided the alkali formed during the reaction is neutralized by a bicarbonate or carbonic anhydride. See abstract for experimental part.

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Address before Bunsen Society at Vienna. The dissociation of SO_2Cl_2 into SO_2 and Cl_2 was studied with many catalysts. Various physical constants determined.

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Conductivity of liquid sulfur was measured up to b. p. 450° and data given.

39 Zerner, E., Weisz, H., and Opalski, H. *C.A.* 1923, 1545. *Z. angew Chem.* 36, 6. Miscibility of Hydrocarbons in Liquid Sulfur Dioxide.
The conclusions of Fontein (*Z. angew. Chem.* 36, 4-6) relative to PhCH_3 and tetralin are accepted.

40 Zuckschwerdt, S. *B.A.* 1874, 674. *Ber.* 7, 292-4. Action of Sulfur Dioxide on Zinc Ethide.
Prepared ethyl sulfinic acid from zinc ethide and SO_2 .

41 Zuckschwerdt, S. *B.A.* 1875, 343. *Ann.* 174, 308-21. Products of the Oxidation of Ethyl Sulfinic Acid by Nitric Acid.
Zinc ethyl sulfinate was prepared from zinc ethyl and sulfur dioxide. When oxidized with nitric acid gave sulfonic acid. Forms a small amount of a complex compound.

CROSS REFERENCES

Group 2—84, 112, **Group 3**—2, 49, 79, 84, 87.

GROUP 7

SULFURYL CHLORIDE (SO_2Cl_2) AND THIONYL CHLORIDE (SOCl_2) IN REACTIONS WITH ORGANIC COMPOUNDS WHERE THERE IS AN INTRODUCTION OF SULFUR INTO THE COMPOUND FORMED

1 Anschutz, A., and Posth, W. *B. A. 1895*, i, 23. *Ber.* **27**, 2751-3. Ethereal Salts of Catechol and Phosphorus and Sulfurous Acids. Catechol sulfite is prepared from catechol and thionyl chloride. Colorless, mobile liquid, b. p. 210° - 211° , sp. gr. 1.409 at 15° . Vapor has unpleasant odor and causes flow of tears.

2 Barger, G., and Ewins, A. J. *C. A. 1909*, 1011. *Proc. Chem. Soc.* **24**, 237. *J. Chem. Soc.* **93**, 2086-90. The Synthesis of Thionaphthene Derivatives from Styrenes and Thionyl Chloride. When 3, 4-methylenedioxypyrimidylmethylicarbinol is treated with thionyl chloride a cyclic carbonate containing S is formed. Reactions of other styrene derivatives carried out.

3 Beckurts, H., and Otto, R. *B. A. 1879*, 229. *Ber.* **11**, 2061-6. Mode of Action of Sulfuric Hydroxychloride. Sulfonates aromatic hydrocarbon. Thiophenol gives disulfide and sulfur dioxide.

4 Behrend, P. *B. A. 1877*, i, 182. *Ber.* **9**, 1334-8. Action of Sulfuryl Chloride on Alcohol. Prepared methyl and ethyl sulfates.

5 Behrend, P. *B. A. 1877*, ii, 287-91. *J. prakt. Chem.* [2] **15**, 23-42. Sulfuryl Chloride and its Behavior to Alcohols. Prepared alkyl sulfates and alkyl chlorosulfates.

6 Behrend, P. *B. A. 1880*, 310. *J. prakt. Chem.* [2] **20**, 382-4. Action of Sulfuric Monochloride on Alcohols. Said to have gotten $\text{EtO} \cdot \text{SO}_2 \cdot \text{Cl}$ which Claesson did not get. Polemical.

7 Bert, L. C. *A. 1924*, 2496. *Compt. rend.* **178**, 1826-8. A New Method of Preparation of Sulfoxides. Prepared by action of SOCl_2 on RMgX compounds.

8 Bottinger, C. *B. A. 1878*, 863. *Ber.* **11**, 1409. Action of Sulfuryl Chloride on Benzene. Products not identified. See also *Ber.* **11**, 1407; *B. A. 1878*, 863, for action on aniline.

9 Courant, E., and Richter, V. v. *B. A. 1886*, 217. *Ber.* **18**, 3178-80. Preparation of Alkyl Disulfides. Sulfuryl chloride on mercaptan yields disulfides. Good yields.

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11 Grignard, V., and Zorn, L. *C. A. 1910*, 2098. *Compt. rend.* **150**, 1177-9. Action of Thionylchloride on Mixed Magnesium Organic Compounds. Reacts energetically with SOCl_2 giving sulfoxides and sulfides. Several cases given.

12 Hemilian. *B. A. 1873*, 747. *Ber.* **6**, 196. Preparation of Sulfo-butyric Acid. Sulfur monochlorhydrin acts on butyric acid at 148° forming sulphobutyric acid.

13 Holmberg, B. *C. A. 1907*, 1975. *Ber.* **40**, 1741-3. Esters of Orthotrichioformic Acid. EtSH and Et formate condense in a freezing mixture in presence of HCl gas forming $\text{HC}(\text{SEt})_3$. Stable towards alkali, HCl hydrolyzes it. Sulfuryl chloride forms diethyl sulfide. KMnO_4 yields the sulfone. $\text{C}_6\text{H}_5\text{SH}$ forms a similar thioformate $\text{HC}(\text{SPh})_3$.

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17 Michaelis, A., and Schifferdecker, O. *B. A. 1874*, 21. *Ber.* **6**, 996-9. Sulfur Oxytetrachloride. Sulfur hydroxychloride mixed with sulfur tetrachloride, cooled to -18° , saturated with dry chlorine, a crystalline mass of formula $\text{S}_2\text{O}_3\text{Cl}_4$ separates.

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20 Michaelis, A., and Godchaux, E. B.A. 1891, 74. Ber. 23, 3019-23. Action of Thionyl Chloride on Secondary Aromatic Amines. Preparation of sulfoxides. Compare B.A. 1890, 610.

21 Michaelis, A., and Storbeck, O. B.A. 1893, i, 249. Ber. 26, 310-1. Thionyl-diethylhydrazone. Prepared by adding an ethereal solution of thionyl chloride to an ice cold ethereal solution of diethylhydrazine. Colorless oil, distills at 73° (20 mm.) undecomposed and is gradually decomposed by water.

22 Michaelis, C. A. A. B.A. 1895, i, 430. Ber. 28, 1012-19. Action of Inorganic Chlorides on Piperidine and the Fatty Amines. Sulfur chloride on piperidine forms thiopiperidine. 1-Thionylpiperidine is obtained by the action of thionyl chloride on piperidine. Properties and reactions given.

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24 Smiles, S., and Bain, A. W. C.A. 1908, 84. Proc. Chem. Soc. 23, 161. J. Chem. Soc. 91, 1118-21. Phenol-p-sulfoxide. Formed by action of thionyl chloride and $AlCl_3$ on phenol. Diacetyl and dibenzoyl derivatives given. Converted into sulfone by permanganate. Ethyl iodide and alkali give *p*-phenethyl-sulfoxide. Condensation with salicylic acid given.

25 Strecker, W. C.A. 1910, 2467. Ber. 43, 1131-6. Action of Magnesium Or-

ganic Compounds on Boron Trichloride, Sulfur Chloride and on the Chloride and Ester of Sulfurous Acid. BCl_3 on $PhMgBr$ yields phenyl boric acid. S_2Cl_2 gives Ph_2S_2 . $SOCl_2$ gives the sulfoxide. Sym. diethyl sulfate gives sulfoxides with the Grignard reagent.

26 Tasker, H. S., and Jones, H. O. C.A. 1911, 3569. Proc. Chem. Soc. 26, 234. Interaction of Phenylmercaptan and Thionyl Chloride.*

27 Tassinari, G. B.A. 1891, 186. Gazz. chim. ital. 20, 362-6. Action of Thionyl Chloride on the Phenols. Products formed are in variable quantities of: 1. compound of high melting point not further examined; 2. a dihydroxythiobenzene identical with that obtained by the action of sulfur dichloride on phenol (B.A. 1889, 245) and, 3. chlorinated and sulfuretted resins.

28 Tohl, A., and Framm, F. B.A. 1894, i, 556. Ber. 27, 2012-6. Sulfonepiperidine and its Oxidation Product. Sulfuryl chloride reacts with piperidine as with secondary amines forming sulfonepiperidine. Its properties studied.

29 Voswinkel, A. B.A. 1896, i, 378. Pharm. Ztg. 40, 241-2. Thio-derivatives of Phenols. Action of thionyl chloride on phenols. See Tassinari, B.A. 1891, 186.

CROSS REFERENCES

Group 2—30, 74; Group 6—7, 37.

GROUP 8

SULFUR DICHLORIDE (SCl_2) AND SULFURCHLORIDE (S_2Cl_2) IN REACTIONS WITH ORGANIC COMPOUNDS WHERE THERE IS AN INTRODUCTION OF SULFUR INTO THE COMPOUND FORMED

1 Angeli, A., and Magnani. B.A. 1894, i, 547. Gazz. chim. ital. 24, i, 342-70. Action of Chloride of Sulfur on Acetylacetone. Acetyl acetone reacts violently with sulfur dichloride to form thioacetylacetone. Derivatives studied.

2 Beckmann, E. C.A. 1909, 1123. Z. physik. Chem. 65, 289-337. The Compounds of Sulfur with Chlorine. S_2Cl_2 , SCl_2 and SCl_4 were found to exist.

3 Bloch, I., and Hohn, F. C.A. 1922, 2109. Ber. 55B, 53-7. Symmetrical Dichlorodimethyl Sulfide. Obtained when trithioformaldehyde is cautiously treated with cold S_2Cl_2 .

4 Bougault, J. B.A. 1896, i, 662. Compt. rend. 123, 187-9. Action of Sulfur Chloride on Pentyerythritol. Forms pentyerythritol disulfide.

5 Buckka, K. B.A. 1885, 1200. Ber. 18, 2090-3. Action of Sulfur Chloride on Ethyl Sodaacetacetate. Prepared $S(CHAc \cdot COOEt)_2$ by the action of sodacetacetate on sulfur chloride. Impossible to reduce because sulfur was eliminated.

6 Chakravarti, G. C. C.A. 1923, 2557. J. Chem. Soc. 123, 964-8. Action of Sulfur Monochloride on Mercaptans. With real mercaptans, compounds of the type $(RS)_2S \cdot S$ are formed. With potential mercaptans sulfur is partly eliminated, and in some cases the molecule is completely ruptured.

7 Delisle, A. B.A. 1887, 915. Ber. 20, 2008-9. Action of Sulfur Dichloride on Ethyl Acetoacetate. Vigorous reaction with formation of a compound $C_{10}H_{14}O_4S$.

8 Delisle, A. B.A. 1889, 488. Ber. 22, 306-9. Ketosulfides and Ketosulfide-acids.
Treats ethyl acetoacetate with sulfur dichloride.

9 Eberhard, O. B.A. 1896, i, 16. Ber. 28, 2385-6. Chloro-derivatives of α , α -Dithienyl.
Concentrated sulfuric acid on monochlorothiophene forms monochlor dithienyl. With sulfuryl chloride this forms tetrachlor dithienyl.

10 Edeleano, L. B.A. 1891, 1202. Bull. soc. chim. [3] 5, 173-5. Action of Sulfur Chloride on Aniline.
Formation of a sulfide.

11 Fawsitt, C. A. B.A. 1889, 317. J. Soc. Chem. Ind. 7, 552-4. Action of Sulfur Chloride on Oils.
Used for testing oils by noting temperature rise.

12 Ferrario, E., and Vinay, H. C.A. 1910, 2447. Bull. soc. chim. 7, 518-27. Action of the Halogen Derivatives of Sulfur on Magnesium Organic Compounds.
 S_2Cl_2 on $PhMgBr$ gave $PhCl$, Ph_2 , Ph_2S , Ph_2S_2 , Ph_2S_3 , and Ph_2S_4 . SCl_2 reacts in same way, forming more $PhCl$ and less Ph_2S , Ph_2 , and only traces of Ph_2S_2 .

13 Henriques, R. B.A. 1895, i, 103-5; 1895, i, 237. Ber. 27, 2993-3005; 28, 114. Thio-derivatives of β -Naphthol.
Sulfur chloride in chloroform gave di β -hydroxy dinaphthyl sulfide, a corresponding tetrasulfide and disulfide. Also prepared dinaphthylene thiophene. See abstract or original. See G. Tassiniari, Ber. 27, 3238; B.A. 1895, i, 150, as well as B.A. 1887, 807; 1889, 245. See M. Schiller-Wechsler, Ber. 27, 3448-9; B.A. 1895, i, 150, for further corrections.

14 Klasen, P. B.A. 1888, 356. Ber. 20, 3413-5. Alkyl Polysulfides.
Pass RSH into S_2Cl_2 and a product is formed free from chlorine. Distilled in vacuum gives trisulfide. Described methyl derivative.

15 Kraft, F., and Lyons, R. E. B.A. 1896, i, 297. Ber. 29, 435-43. Thianthrene (Diphenylene Disulfide) $C_{12}H_8S_2$ and Selenanthrene, I.
Gives preparation from benzene, $AlCl_3$ and SCl_2 . Prepared dioxide, sulfide sulfone, and disulfone.

16 Lengfeld, F., and Stieglitz, J. B.A. 1895, i, 264. Ber. 28, 575-6. Thiamines.
Prepared tetramethylthiodiamine from sulfur dichloride and diethylamine.

17 Lippman, E., and Pollak, I. B.A. 1902, i, 750. Monatsh. 23, 669. Action of Sulfur Chloride on Benzene.
Commercial benzene warmed on a water bath with 15% of sulfur chloride until the evolution of HCl ceases (192 hours) and then washed with dilute sodium hydroxide solution and dried over calcium chloride, it distills at 81° and is free from thiophene.

18 Lorand, E. C.A. 1927, 2554. Ind. Eng. Chem. 19, 733-5. Action of Sulfur Monochloride on Petroleum Hydrocarbons.
Action one of chlorination and subsequent polymerization or condensation. Two methods are suggested for testing the degree of unsaturation of hydrocarbons on basis of this action.

19 Magnani, F. B.A. 1894, i, 209. Gazz. chim. ital. 23, ii, 415-9. Action of Sulfur Chloride on Acetylacetone.
Sulfuryl chloride acts rapidly on acetylacetone to form dithiodiacetyl acetone, m. p. 89°-90°. Gives condensation products with hydroxylamine and phenylhydrazine.

20 Mann, F. G., and Pope, W. J. C.A. 1923, 2557. J. Chem. Soc. 123, 1172-8. α , α' -Dichlorodialkyl Sulfides.
 S_2Cl_2 reacts with $(CH_2S)_3$ to give a 70% yield of $(CH_2Cl)_2S$. Yield is quantitative if SCl_2 is used.

21 Michaelis, H., and Schifferdecker, O. B.A. 1873, 132 Ber. 5, 924-8. Existence and Dissociation of Sulfur Tetrachloride.
Discusses existence and reactions of sulfur tetrachloride.

22 Michaelis, A., and Schifferdecker, O. B.A. 1874, 20. Ber. 6, 993-6. (Ann. Chem. Pharm. 170, 1-42.) B.A. 1874, 225. Existence and Decomposition by Heat (Dissociation) of Sulfur Tetrachloride.
Studied decomposition of sulfur tetrachloride at -20° C. When heated to 6° C. goes to sulfur dichloride. Studied decomposition of sulfur dichloride to sulfur chloride with temperature.

23 Michaelis, A., and Luxembourg, K. B.A. 1895, i, 200. Ber. 28, 165-7. A New Series of Sulfur Derivatives of Aliphatic Amines.
Preparation of dithiodiamines with secondary amines.

24 Naik, K. G. C.A. 1921, 2882. J. Chem. Soc. 118, 1166-70. Interaction of Sulfur Monochloride and Organic Acid Amides.
Oxamide, succinamide, malonamide, phthalamide, and phthalimide do not react. Acetamide, benzamide, butyramide, and urea form n-sulfidobisderivatives.

25 Naik, K. G., and Bhat, G. N. C.A. 1928, 3129. Quart. J. Indian Chem. Soc. 4, 525-30. Formation and Properties of Dithioketones and Dithioethers. IV. Interaction of Sulfur Monochloride with Organic Compounds Containing the Reactive Methylene Group.*

26 Orloff, N. A. B.A. 1901, ii, 499. J. Russ. Phys. Chem. Soc. 33, 400-3. Formation of the Green Variety of Sulfur.
Formed by the action of sulfurmonochloride on metallic sulfides in benzene solution.

27 Schmidt, E. B. B.A. 1878, 974. Ber. 11, 1168-75. Action of Halogen Sul-

fur Compounds on Aniline, Acetanilide, and Benzene.

Various sulfur nitrogen compounds first. Chloride of sulfur and benzene no reaction to give sulfur compounds. When zinc dust is added to a hot mixture of sulfur chloride and benzene, a violent reaction occurs and HCl is evolved. Phenyl disulfide can be isolated by benzene and steam distillation. On direct distillation up to charring found phenyl mercaptan, phenyl sulfide, diphenylene sulfide. Organic zinc compound was supposed to have been formed but not pure.

28 **Spring, W. H. B.A. 1874, 123. Ber.** 6, 1108-11. The Polythionic Acids. See abstract. Inorganic only.

29 **Spring, W., and Lecrenier, A. B.A. 1888, 664. Bull. soc. chim. [2] 48,** 623-8. Action of Chlorine on the Sulfides of Alcoholic Radicals. Preparation of Some New Chlorine Derivatives.

Sulfur derivatives (sulfides, hydrosulfides, and disulfides) of propyl, isobutyl, and amyl treated with dry chlorine; the sulfur goes out as sulfur dichloride.

30 **Tassinari, G. B.A. 1887, 807. Gazz. chim. ital.** 17, 83-7, 90-4. Action of Sulfur Dichloride on Phenol. Formation of sulfides.

31 **Tassinari, R. B.A. 1889, 245. Rend. Acad. dei Lincei [4] 4, ii, 47-51. Chem. Centr.** 1888, 1354. Dihydroxythiobenzene.

Reports on products formed by the action of sulfur dichloride on parabromophenol. Prepared sulfones.

32 **Tohl, A., and Eberhard, O. B.A. 1894, i, 117. Ber.** 26, 2945-7. Formation of Dithienyl Derivatives of Thiophene.

Sulfuryl chloride mixed with thiophene and a small amount of $AlCl_3$ is added, a violent action takes place. Product chiefly

trichlorodithienyl and dichlorodithienyl and a small amount of chlorothiophene. Constants and derivatives given.

33 **Troeger, J., and Horning, V. B.A. 1899, i, 905. J. prakt. Chem. [2] 60,** 113-40. Action of Sulfur Monochloride and Dichloride on Sulfonates, Thiosulfonates and Mercaptans. See abstract for compounds studied.

34 **Vaillant, V. B.A. 1895, i, 168. Compt. rend.** 119, 647-50. Action of Sulfur Chloride on the Copper Derivative of Acetyl Acetone and Benzoylacetone. Formation of thioderivative.

35 **Vaillant, V. B.A. 1903, i, 639. Bull. soc. chim. [3] 29,** 528-30. Thiobenzoylacetone.

Sulfur dichloride on the copper derivative of benzoyl acetone yields thiobenzoylacetone; natural to litmus. Forms sodium, copper, ferric and ammonium derivative.

36 **Warren, T. T. P. B. B.A. 1888, 633; 1888, 199. Chem. News.** 57, 113; 56, 222, 231, 243-4. Action of Sulfur Chloride on Oils.

Used in testing of oils. *Chem. News.* 58, 4, 15; *B.A.* 1888, 1348.

37 **Wolff, H., and Ott, A. B.A. 1904, i, 8. Ber.** 36, 3721-6. Action of Sulfur Chloride on Ethyl and Methyl Malonates.

Prepared with sulfur chloride, aluminum chloride, and ethyl malonate $S_2(CH(COOC_2H_5)_2)_2$. Also prepared methyl trithiomalonate.

CROSS REFERENCES

Group 2—20, 30, 74, 76; **Group 5**—71, 72, 78; **Group 6**—34; **Group 7**—17, 22, 25.

GROUP 9

THIOPHOSGENE ($CSCl_2$)

1 **Autenrieth, W., and Hefner, H. C.A. 1926, 914. Ber.** 58B, 2151-6. Experiments with Thiophosgene.

With $o-C_6H_4(NH_2)_2$, $CSCl_2$ readily yields a cyclic compound $SC(NH_2)_2C_6H_4$, but reacts differently with other amines.

2 **Bergreen, H. B.A. 1887, 937. Ber.** 20, 1965-6. Carbon Thiodichloride.

Prepared from carbon thiodichloride, tetraphenylthiocarbamide, thiobenzophenone ethyl thiocarbonate, ethyl chlorothiocarbonate, phenyl thiocarbonate, ethyl thiocarboxylacetate and ethyl thiocarboxymalonate.

3 **Berggreen, H. B.A. 1888, 444. Ber.** 21, 337-52. Thiocarbonyl Chloride. Prepared thioketones, thiocarbonates.

4 **Carrara, G. B.A. 1894, ii, 15. Gazz. chim. ital.** 23, ii, 12-7. Polymeric Thiocarbonyl Chloride.

Polymer of thiocarbonyl chloride is the di-body.

5 **Eckenroth, H., and Kock, K. B.A. 1894, i, 408. Ber.** 27, 1368-71. Diphenylic Thiocarbonate.

Prepared by dropping thiophosgene into aqueous solution of sodium phenoxide. m. p. 106°; b. p. 336°-340°, with slight decomposition. Studied its properties.

6 **Eckenroth, H., and Kock, K. B.A. 1895, i, 131. Ber.** 27, 3410-12. Diphenylic Thiocarbonate. See same author, *B.A.* 1894, i, 408.

Nitric acid converts diphenylic thiocarbonates to phenylic carbonates. Prepared various aromatic thiocarbonates by thiophosgene and sodium salt of phenol.

7 Gattermann, L. B.A. 1896, i, 72. *Ber.* **28**, 2869-77. Colored Aromatic Thioketones.

Prepared thioketones from thiophosgene, aluminum chloride and aryl compound. Hard to prepare derivatives from thioketones on account of the ease with which the sulfur is eliminated. See abstract for compounds prepared.

8 Holzmann, E. B.A. 1888, 1080. *Ber.* **21**, 2056-71. Thio-derivatives of Some Secondary and Tertiary Amines.

Sulfur dichloride and aromatic amines form sulfides.

9 Hostmann, G. B.A. 1897, i, 475. *Diss. Rostock, 1895.* 1-40. See *Chem. Zentr.* **1896**, ii, 663-4. Aromatic Thio-

ketones and Resorcinol Dimethyl Ether.

Condenses thiophosgene and aryl compounds with AlCl_3 . Gives thioketones.

10 Jaffe, M., and Kuhn, B. B.A. 1894, i, 437. *Ber.* **27**, 1663-6. Action of Thiocarbonic Chloride on Ethylenediamine. Condensation product formed with elimination of HCl and H_2S .

11 Rathke, B. B.A. 1888, 1169. *Ber.* **21**, 2539-45. Methyl Chlorothioformate; Polymeric Thiocarbonyl Chloride.

Polymeride obtained by exposing thiophosgene to light, m. p. 116°.

CROSS REFERENCES

Group 2—29, 63; Group 4—15.

GROUP 10

MERCAPTANS

1 Adams, R., Bramlet, H. B., and Tendick, F. H. C.A. 1921, 672. *J. Am. Chem. Soc.* **42**, 2369-74. Action of Grignard Reagent on Thiocyanates. Sulfides and mercaptans were formed depending upon the conditions of the experiment.

2 Adams, R., and Marvel, C. S. C.A. 1926, 177. *Organic Syntheses I*, 71-4. Thiophenol.

Reduction of PhSO_2Cl with Zn and sulfuric acid gives 91% of PhSH.

3 Albreht, M. B.A. 1872, 403. *Ann. Chem. Pharm.* **161**, 129-48. Methylmercaptantrisulfonic Acid, Methylmercaptandisulfonic Acid and Methylalco-holtrisulfonic Acid.

Studied the reactions of perchloro-methylmercaptan with neutral potassium sulfite. Forms trisulfite salt. Can be washed with dilute acetic acid and with lead acetate forms lead salt of the disulfide acid.

4 Allert, R. B.A. 1881, 902. *Ber.* **14**, 1434-8. Derivatives of Metachloronitrobenzene and Orthochlorobenzene Sulfonic Acid.

Reduced sulfonic chloride to mercaptan to form $\text{C}_6\text{H}_4\text{CINH}_2\text{SH}$. No organic bases could be produced by the action of organic acids or acid chlorides on this compound.

5 Andreasch, R. B.A. 1880, 236. *Ber.* **12**, 1390-2. Characteristic Reaction of Thioglycollic Acid.

If a drop of dilute ferric chloride is added to a slightly acidified solution of a thioglycolate, a transient indigo blue color appears and on adding ammonia in excess the solution takes a deep violet-red color which becomes more intense on agitating with air. Thiodiglycollic acid does not give test.

6 Andreasch, A. B.A. 1882, 407. *Monatsh.* **2**, 775-81. Synthesis of Thiohydantoins by Means of Thioglycollic Acid.*

7 Arndt, F., Milde, E., and Eckert, G. C.A. 1922, 1073. *Ber.* **54B**, 2236-42. Preparation of Methyl Mercaptan. Obtained by treating $\text{CS}(\text{NH}_2)_2$ with Me_2SO_4 in water.

8 Austin, P. T., and Smith, F. S. B.A. 1886, 693. *Am. Chem. J.* **8**, 89-92. Dinitrophenylthiocyanate.

Boil dinitro bromobenzene with KSCN in alcohol. Heated with concentrated sulfuric acid gives mercaptan. Dinitrophenyl sulfide formed by treating dinitrothiocyanate with strong nitric and sulfuric acids.

9 Autenrieth, W. B.A. 1891, 203. *Ann.* **259**, 362-4. Benzenesulfonic Acid and Ethylsulfonic Acid.

Benzenesulfonic acid when pure and dry does not readily undergo oxidation on exposure to air. Sodium salt very stable. Ethyl sulfonic acid is unstable but the dry sodium salt is oxidized slowly by the air. Method of preparation from mercaptan to sulfonic acid to sulfonchloride to sulfonic acid given.

10 Autenrieth, W. B.A. 1891, 567. *Ber.* **24**, 166-72. Substituted Sulfones. Compare E. Stuffer (B.A. 1891, 180). Prepared substituted mercaptans from substituted acetone.

11 Autenrieth, W., and Wolff, K. B.A. 1899, i, 579. *Ber.* **32**, 1368-75. Trimethylene Mercaptan and the Trimethylenedisulfones.

Mercaptan prepared from bromide and alc. KSH . Prepared trimethylene dithiobenzoate, dithiophthalate and dimethyl

sulfide. Oxidized the sulfides to sulfone. Sulfones are not hydrolyzed by alkalies so agree with Stuffer's generalization.

12 Autenrieth, W., and Wolff, K. B.A. 1899, i, 580. Ber. 32, 1375-90. Cyclic Disulfides and Disulfones. Trimethylene dimercaptan reacts with formaldehyde. This ring sulfide is oxidized to disulfone. Hydrogens on methylene group between two sulfones replaceable with bromine or alkyl groups. See abstract.

13 Autenrieth, W., and Hennings, R. B.A. 1901, i, 560. Ber. 34, 1772-8. Ring Compounds Containing Sulfur. *o*-Xylylene mercaptan condenses with acetone in HCl to form ring. Oxidized to disulfone. Cannot be reduced to mercaptan.

14 Autenrieth, W., and Hennings, R. B.A. 1902, i, 389. Ber. 35, 1388-1400. Cyclic Compounds Containing Sulfur. Prepared ring sulfides from *o*-xylylene dmercaptan and carbonyl oxygen from formaldehyde, acetaldehyde, acetophenone. Also prepared disulfones. See abstract for different compounds prepared.

15 Autenrieth, W., and Bruning, A. B.A. 1903, i, 272. Ber. 36, 183-190. Cyclic Compounds Containing Sulfur. Continuation of studying derivatives of *o*-xylylene. See abstract for a compound supposed to have sulfur to sulfur linkage and still be of sulfonium type.

16 Autenrieth, W., and Bruning, A. B.A. 1904, i, 35. Ber. 36, 3464-9. Condensation of Mercaptans with Nitriles. Condense nitrile and mercaptan with dry HCl to form $\text{NH:CR-SR}'$.

17 Autenrieth, W., and Geyer, A. C.A. 1909, 646. Ber. 41, 4249-56. Penta-methyl Mercaptan and Four-membered Cycloidal Mercaptoles and Disulfones. Mercaptan prepared from $\text{C}_5\text{H}_{10}\text{Br}_2$ and alc. KSH. KMnO_4 converts the thioether into disulfone. Mercaptan condenses in presence of Et_2O and HCl to cycloduplo 1, 3-dithio-2, 2-dimethyl hexamethylene.

18 Autenrieth, W., and Geyer, A. C.A. 1909, 647. Ber. 41, 4256-8. Action of Phosphorus Pentachloride and Phosphorus Pentabromide on Mercaptans. PhSH and BzSH (2 mol.) freshly distilled and free from disulfides were treated at -15° with dry PCl_5 and PBr_3 . Phenyl and benzyl disulfides together with PCl_5 , HCl , PBr_3 and HBr were formed.

19 Autenrieth, W., and Beuttel, F. C.A. 1910, 457. Ber. 42, 4346-57. Cyclic Compounds of Four Members which Contain Sulfur and Para-ring Formation. *p*-Xylylenemercaptan, its disulfone and disulfoxide are given. Duplo-*p*-xylylenebenzo-, *p*-tolyl, *m*-tolyl, *p*-hydroxybenzo-, and *m*-hydroxybenzo-mercaptans are given. The tetra sulfones are given for the first two.

20 Autenrieth, W., and Beuttel, F. C.A. 1910, 458. Ber. 42, 4357-61. Cyclic Compounds of Four Members Containing Sulfur and Meta-ring Formation. *m*-Xylylene mercaptan and its dibenzyl sulfone given. Duplo-*m*-xylylenemercaptone and its tetrasulfone given.

21 Auwers, K., and Arndt, F. C.A. 1909, 2577. Ber. 42, 2706-12. Conversion of Thiophenol Ethers into Thioflavone Derivatives. Prepared by action of dry HCl, BzH and 3-aceto-4-thiocresyl methyl ether. Dibrom derivative given. Various other compounds given.

22 Barbaglia, G. A. B.A. 1872, 1017. Ber. 5, 687-9. Benzylsulfonic Acid. Prepared from benzyl disulfide and HNO_3 , giving much benzaldehyde, little benzoic acid at the same time. Benzyl sulfonycyanate from benzylchloride and potassium sulfonycyanate gave no sulfo acid, only benzoic acid and benzaldehyde.

23 Barber, H. J., and Smiles, S. C.A. 1928, 3153. J. Chem. Soc. 1928, 1141-9. Cyclic Disulfides Derived from Diphenyl. Many compounds and their properties are given.

24 Barkenbus, C., Friedman, E. B., and Flege, R. K. C.A. 1927, 3898. J. Am. Chem. Soc. 49, 2549-53. Reaction of *p*-Substituted Benzyl Chlorides with Sodium Hydrogen Sulfide. *p*-Substituted mercaptans and sulfides were obtained.

25 Bauman, E., and Preusse, C. B.A. 1879, 803. Ber. 12, 806-10. Bromophenyl-mercapturic Acid. Biological and some chemical data. See abstract.

26 Baumann, E., and Preusse, C. B.A. 1882, 756-7. Z. physiol. Chem. 5, 309-43. Synthetic Processes in the Animal Body. Studies constitution of bromophenylcystine and cystine.

27 Baumann, E. B.A. 1882, 1282. Ber. 15, 1731-5. Phenylmercapturic Acid, Cystine, and Serine. Decomposition of acids given.

28 Baumann, E. B.A. 1884, 1382. Z. physiol. Chem. 8, 299-305. Cystine and Cysteine. Preparation.

29 Baumann, E. B.A. 1885, 513-5. Ber. 18, 258-67. Derivatives of Pyuric Acid. Studied behavior and its relationship to mercapturic acids. Compares with cystine. See abstract.

30 Baumann, E. B.A. 1885, 748. Ber. 18, 883-92. Compounds of Mercaptans with Aldehydes, Ketones and Ketonic Acids. See *B.A. 1335, 513*. Formed mercaptals or thioacetals. See abstract for those formed.

31 Baumann, E. B.A. 1887, 126. Ber. 19, 2803-6. Compounds of Aldehydes and Ketones with Mercaptans.

In acid solution aldehydes or ketones combine with mercaptans with the elimination of one molecule of water forming mercaptals (mercaptoles).

32 Baumann, E. B.A. 1890, 1092. Ber. 23, 1869-76. Action of Hydrogen Sulfide on Aldehydes.
Compare *B.A.* 1890, 477. Studied reaction between formaldehyde and hydrogen sulfide to form polysulfide—partly sulfide and partly disulfide. Prepare trisulfone dimethyl dimethylene trisulfone.

33 Bechler, M. B.A. 1874, 471. J. prakt. Chem. [2] 8, 167-82. Cymene Mercaptan and Researches on the Constitution of Thymol.
Prepared from cymene sulphochloride by reduction. Methyl ether prepared. This was desulfurized by passing over heated copper turnings. Discusses position of mercaptan group.

34 Bennett, G. M., and Whincop, E. M. C.A. 1922, 409. J. Chem. Soc. 119, 1860-4. Some Derivatives of Mono-thioethylene.
Derivatives of PhCNO , $\text{p-O}_2\text{NC}_6\text{H}_4\text{COCl}$, $\text{C}_6\text{H}_5\text{Br}_2$, SOCl_2 given.

35 Bennett, G. M. C.A. 1923, 61. J. Chem. Soc. 121, 2139-46. Monothio-ethylene Glycol.
Its constants and various metal derivatives are given.

36 Bennett, G. M., and Berry, W. A. C.A. 1927, 3191. J. Chem. Soc. 1927, 1666-76. Monothioethylene Glycol. III, Nitrophenyl Thioethers.
Preparation, properties and derivatives given.

37 Bennett, H. T., and Story, L. G. C.A. 1927, 2979. Oil and Gas J. 27, No. 48, 162. Sulfur Compounds in Oil Distillate.
Sulfuric acid used in treating gasoline containing BuSH produces Bu_2S_2 and $\text{Bu}_2\cdot\text{S}\cdot\text{SO}_2$, while doctor solution and hypochlorite produces disulfides. Doctor reduces the sulfur content more than hypochlorite.

38 Berlinerblau, J. B.A. 1886, 326. Ber. 19, 124-6. Homologues of Rhodanic Acid.
Heated α -chloropropionic acid with concentrated solution of ammonium thiocyanate forming $\text{SH}\cdot\text{CHMe}\cdot\text{CO}\cdot\text{S}\cdot\text{CN}$. Will report products of hydrolysis later.

39 Bernthsen, A. B.A. 1887, 245. Ber. 19, 3255-6. New Synthesis of Thiodiphenylamine.
Heat orthoamidophenyl mercaptan and catechol.

40 Bernthsen, A. B.A. 1893, i, 75. Ber. 25, 3128-39. Metamido-dialkylorthotoluidines and their Conversion into Methylene Blue Dyes.
Formation of thiosulfate salts, warming with soda to form bisulfide and then reducing with zinc HCl to form mercaptan.

41 Biedermann, R. B.A. 1876, i, 695. Ber. 8, 1674-7. Oxymercaptans.
Amidophenylmercaptan with alkali forms high boiling oil smelling like mushrooms. Supposed to form a phenolthiophenol.

42 Biedermann, A. B.A. 1886, 787. Ber. 19, 1615-20. Thiophenol and the α -Naphthol of the Thiophene Series.
Add gradually zinc thiophene sulfinate to zinc and hydrochloric acid to form thionylmercaptan. Oxidizes to disulfide. Yield very poor. Prepares also hydroxythionaphthene.

43 Biilmann, E. B.A. 1905, i, 625. Ann. 339, 351-72. Preparation of Thio-acids and Disulfo-acids.
Non-crystalline thio-acids can be prepared by treating alkali salts of halogen substituted fatty acids with potassium xanthate in aqueous solution; on further treatment with ammonia the xanthamides are formed.

44 Biilmann, E. B.A. 1906, i, 625. Ann. 348, 120-32; 133-43. Organic Thio-acids, II and III.
Gives methods of preparation, physical properties, and salts.

45 Biilmann, E., and Due, N. V. C.A. 1924, 2003. Bull. soc. chim. 35, 384-90. The Action of Triphenyl Methyl Chloride on Compounds Containing a Free Sulphydryl Group.*

46 Birch, S. F., and Norris, W. S. G. P. C.A. 1926, 278. J. Chem. Soc. 127, 1934-44. Chemistry of Petroleum. II, Action of Sodium Hypochlorite on Sulfur Compounds of the Types Found in Petroleum Distillates.
Certain sulfides were oxidized wholly or in part to the analogous sulfones when shaken (15 minutes to 2 hours) in equal volume with a solution of NaOCl . Elemental sulfur is not attacked. H_2S is oxidized to water, sulfur and some sulfuric acid. Thiophene is not attacked.

47 Bistrzycki, A., and Kuba, F. C.A. 1922, 711. Helv. Chim. Acta. 4, 969-81. Ring Condensations of Thiophenol Ethers.*

48 Bistrzycki, A., and Risi, J. C.A. 1926, 375. Helv. Chim. Acta 8, 582-91. Action of Benzilic and Anisilic Acids on Thiophenols.*

49 Blanksma, J. J. B.A. 1902, i, 281. Rec. trav. chim. 20, 399-410. Aromatic Derivatives of Sulfur.
Prepared mercaptans by reacting with sodium sulfide on o-chloronitrobenzene. Other substituted aromatic sulfides, mercaptans, and disulfides prepared.

50 Blanksma, J. J. B.A. 1905, i, 425. Rec. trav. chim. 24, 46-52. Intramolecular Oxidation of a Thiol (SH) Group Joined to a Benzene Nucleus by a Nitro-group in the Ortho Position.*

51 Blomstrand, C. W. B.A. 1873, 505. Ber. 5, 1084-90. Toluenedisulfonic Acid.
Prepared toluene disulphydrate and disulfonic acid from the disulfonic acid. No details in abstract.

52 Bongartz, J. B.A. 1886, 937. Ber. 19, 1931-5. Compounds of Aldehydes,

Ketones, and Ketonic Acids with Thio-glycollic and Thioacetic Acids.
React with aldehydes to form mercaptals.

53 **Bongartz, J. B.A.** 1886, 1000. *Ber.* **19**, 2182-4. Ethenyl Trisulfide.
Heat thioacetic acid with fused zinc chloride for 12 hours forming CMeS_2CMe . KOH and hydrosulfide at 200° - 220° act on it but slightly.

54 **Bondzynski, S. B.A.** 1887, 1108. *Monatsh.* **8**, 349-64. Derivatives of Hydrothiocinnamic Acid.
Gives preparation and some reactions.

55 **Borsche, W., and Lange, W. B.A.** 1906, **i**, 165. *Ber.* **39**, 392-7. Hexahydrothiophenol (Cyclohexyl Mercaptan).
Prepared by reduction of cyclohexane sulfonic chloride. Yield very small from bromide and KSH. Prepared from xanthate derivative and ammonia. Prepared sulfide and other derivatives.

56 **Borsche, W., and Lange, W. B.A.** 1906, **i**, 679. *Ber.* **39**, 2346-56. Thio-borneol and Other Derivatives of Camphane Containing Sulfur.*

57 **Borsche, W., and Lange, W. C.A.** 1907, 2555. *Ber.* **40**, 2220-5. New Alicyclic Compounds Containing Sulfur.
Potassium cyclopentane sulfonate obtained from cyclopentyl bromide and SO_2 and subsequent treatment with KMnO_4 . Sulfoxide, sulfone and thio-m-cresol also formed.

58 **Bottinger, C. B.A.** 1876, **ii**, 624. *Ber.* **9**, 1061-4. Thiolactic Acid.
See *B.A.* 1876, **ii**, 70. Substance formed was thiolactic acid.

59 **Bottinger, C. B.A.** 1879, 138. *Ber.* **11**, 1897-1900. Thioglycollic and Thiodiglycolic Ethers.
Continues investigation from *Ber.* **10**, 1243.

60 **Bottinger, C. B.A.** 1880, 621. *Ann.* **198**, 203. Glyoxylic Acid.
Historical and gives preparation of thioglycolic acid.

61 **Bottinger, C. B.A.** 1885, 752. *Ber.* **18**, 486. Preparation of Thiolactic Acid.
Pyruvic acid is heated with an excess of ammonium sulfide for 2 hours at 110° , product diluted with water, acidulated with sulfuric acid, and extracted with ether; the thiolactic acid obtained is purified by conversion into its ethyl or metallic salts.

62 **Bourgeois, E. B.A.** 1900, **i**, 163. *Rec. trav. chim.* **18**, 426-50. Preparation of Aromatic Thiols.
Two methods improved: 1. the reduction of aromatic sulfochlorides; 2. hydrolysis of aromatic derivatives of xanthogenic acid.

63 **Bourgeois, E., and Petermann, K. B.A.** 1904, **i**, 28. *Rec. trav. chim.* **22**, 349-55 and 356-66. Influence of Sulfur and of Sulfur Containing Groups on the Order of Substitution of Hydrogen Atoms in Cyclic Nuclei. Sulfur Derivatives of Phenyl Sulfide.
Sulfonate diphenyl sulfide goes para. Reduce to dimercaptan. Forms lead salt.

64 **Bourgeois, E., and Fouassin, A. C.A.** 1912, 605. *Bull. soc. chim.* **9**, 938-44. Reactivity of Aromatic Bromine Derivatives. II, Formation of Some Entirely Aromatic Disulfides of Types $\text{R} \cdot \text{S} \cdot \text{R}' \cdot \text{S} \cdot \text{R}$ and $\text{R} \cdot \text{S} \cdot \text{R}' \cdot \text{S}' \cdot \text{R}''$.
When $\text{p-C}_6\text{H}_4\text{Br}_2$ is heated at 200° - 225° with Pb salts of various aromatic mercaptans, mono- and disulfides are formed. As heating is prolonged, proportion of disulfide increases; the more complex the radical of the mercaptide, the greater the amount of disulfide. The per cent of monosulfide formed from various mercaptides is given. Bromo sulfides react easily with Pb mercaptides.

65 **Bourgeois, E., and Huber, P. C.A.** 1912, 606. *Bull. soc. chim.* **9**, 944-7. Reactivity of Aromatic Bromine Derivatives. II, Action of Bromonitrobenzenes on Thiophenolates.
 o - and $\text{p-BrC}_6\text{H}_4\text{NO}_2$ react in cold with NaSC_6H_5 practically quantitatively forming corresponding sulfides. m-Compound gives variety of products.

66 **Bourgeois, E., and Abraham, A. C.A.** 1912, 623. *Rec. trav. chim.* **30**, 407-25. Influence of Sulfur and Sulfur Groups on the Order of Substitution by Bromine of the Hydrogen Atoms in Benzene.
In case of PhSH , no substitution by Br ; PhSSPh formed. Me_2SPh and Ph_2S first form addition products with Br , which then tend to form mono bromo substitution products, sulfur entering the Ph group. With Br in CCl_4 at 0° , Br addition product formed; when heated rapidly HBr evolved. Action of KMnO_4 given.

67 **Brand, K., and Graebe, W. C.A.** 1924, 3180. *J. prakt. Chem.* **108**, 1-18. Thiophenols. VIII, 2-Methyl Mercapto-5-Chlorotriphenylcarbinol.*

68 **Brand, K., Stallmann, O., Groebe, W., and Stein, H. C.A.** 1925, 1257. *J. prakt. Chem.* **109**, 1-40. Thio-phenols and the Increase in Color Produced by the Alkylmercapto Group. X, Halochromism in the Triphenylmethane and Azo Compound.*

69 **Brand, K., and Kranz, K. W. C.A.** 1927, 1105. *J. prakt. Chem.* **115**, 143-62. Thiophenols. XI, Refractometry of Several Methoxy and Methyl Mercapto Compounds.
Mercaptans and sulfides studied.

70 **Brand, K., and Pabst, H. C.A.** 1929, 1128. *J. prakt. Chem.* **120**, 199-213. Thiophenols. XII, Triphenylmethane Series.*

71 **Braun, J. v., and Hahn, E. C.A.** 1926, 2991. *Ber.* **59B**, 1202-9. Firmness of Attachment of Organic Residues. IV, Addendum. Allyl Mercaptan and Cinnamyl Mercaptan.*

72 **Braun, L., and Ebert, R. B. A. 1892, 1471. *Ber.* **25**, 2735-9.** Naphthylene Dihydrosulfide and Dithiocyanate. Give method of preparation from the disulfonic acid on reduction.

73 **Brooker, L. G. S., and Smiles, S. C. A. 1926, 3289. *J. Chem. Soc.* **1926**, 1723-9.** Method of Inserting the Thioaryl Group.*

74 **Busch, M., and Menssdoerffer, E. C. A. 1907, 1547. *Ber.* **40**, 1021-36.** Inner Anhydrides of Thiosemicarbazine-acetic Acid. Hot alkalies eliminate mercaptan. Iodine converts above thiol into disulfide in alkali solution. FeCl_3 also forms the disulfide.

75 **Byasson, H. B. A. 1872, 612. *Compt. rend.* **124**, 1290-2.** On Chloral Sulfhydrate. Chloral absorbs H_2S and after 24 hours solidifies to white crystalline mass which may be distilled; m. p. 770° , b. p. 123° . Soluble in abs. alcohol, ether or CHCl_3 . Decomposes by water with deposition of S. Paper gives properties and reactions. Physiological action similar to chloral.

76 **Cappelli, G. C. A. 1919, 1451. *Gazz. chim. ital.* **48** (2) 107-13.** Thiophenol in Synthetic Phenol. Disagreeable odors present in some synthetic phenols were shown to be thiophenol.

77 **Causse, H. B. A. 1901, ii, 133. *Compt. rend.* **131**, 1220-2.** Action of Sodium p-Diazobenzenesulfonate on Iron Cystinate in Contaminated Water. Test is indicative of certain groupings rather than of a definite substance, for orange coloration not destroyed by sulfuric acid is produced whenever water contains ferrous compounds containing the CSH or COS groups.

78 **Chakravarti, G. C., and Saha, J. M. C. A. 1927, 3192. *Quart. J. Indian Chem. Soc.* **4**, 141-7.** Interaction of Mercaptans with Phthalic Anhydrides and Phthalyl Chloride. Certain dithiophthalates were formed.

79 **Chakravarti, G. C., and Saha, J. M. C. A. 1929, 97. *Quart. J. Indian Chem. Soc.* **5**, 453-8.** Organic Cyclic Polysulfides: Condensation of Ethylene Mercaptan with Di- and Tri-Chloroacetic Acid. Various polysulfides given.

80 **Challenger, F., Jinks, J. R., and Haslam, J. C. A. 1925, 1139. *J. Chem. Soc.* **127**, 162-6.** Sulfur Compounds in Kimmeridge Shale Oil. Sulfides, mercaptans, thiophene and 2-methylthiophene were shown to be present.

81 **Chichibabin, A. E., and Bagdassarjan, O. S. C. A. 1925, 34. *J. prakt. Chem.* **108**, 200-8.** Condensation of Acetylene with Hydrogen Sulfide in the Presence of Aluminum Oxide.

Thiophene, EtSH , sec-BuSH and a mixture of α - and β -ethyl thiophenes were obtained.

82 **Child, R., and Smiles, S. C. A. 1927, 234. *J. Chem. Soc.* **1926**, 2696-702.** Phototropic Aminoaryl Disulfoxides. Various compounds and their properties given.

83 **Claasz, M. C. A. 1913, 85. *Ber.* **45**, 2424-8.** Reduction of Disulfides by Grape Sugar. Preparation of Mercaptans. Pure $\text{o-O}_2\text{NC}_6\text{H}_4\text{SCH}_2\text{CO}_2\text{H}$ was obtained by action of 1 mol. glucose and 3-4 mol. NaOH in alcohol suspension on water bath from $(\text{O}_2\text{NC}_6\text{H}_4\text{S})_2$ and treating the product with $\text{CH}_3\text{Cl CO}_2\text{Na}$. Yield 90-95%.

84 **Claesson, J. P. B. A. 1876, i, 567. *Bull. soc. chim.* [2] **23**, 441-7.** Phenylsulfacetic and Ethylsulfacetic Acids. Phenyl mercaptan, prepared by reducing benzenesulfochloride with tin and HCl , was dissolved in alkali and treated with ethylmonochloroacetate to form ethyl ester of phenylthioacetic acid. Corresponding ethyl and amyl sulfoacetic acids prepared. S oxidized to sulfone with permanganate. Other properties also given.

85 **Claesson, P. B. A. 1876, ii, 504. *Ber.* **9**, 854. Mercaptan. New mercaptides have been prepared. See original.**

86 **Claesson, P. B. A. 1877, i, 585. *Bull. soc. chim.* [2] **25**, 183-7.** On the Mercaptides and Certain Sulfides of Ethyl. Prepared crystalline hydrates of ethyl mercaptan and water. Prepared mercaptides and polysulfides. See abstract or original.

87 **Claesson, P. B. A. 1877, ii, 111. *J. prakt. Chem.* [2] **15**, 218-21.** Behavior of the Sulfides of the Alkali Metals to Water. Discusses factors in preparation of mercaptans and sulfides from metal alkyl sulfide and metal sulfide or sulfhydrate. See abstract or original.

88 **Claesson, P. B. A. 1877, ii, 294-6. *J. prakt. Chem.* [2] **15**, 193-218.** Ethyl Mercaptan. Discusses preparation and many metal mercaptides. See abstract or original.

89 **Claesson, P. B. A. 1881, 580. *Ber.* **14**, 409-11. Dithioglycollic Acid. Thioglycollic acid is oxidized to dithioglycollic acid by copper and iron salt, by iodine, and by exposure to the air. Salts prepared. Oxidized by permanganate to thioacetic acid, which can be reduced to thioglycollic acid again with zinc and dilute sulfuric acid.**

90 **Claesson, P. B. A. 1881, 646. *Ber.* **14**, 411-2.** Characteristic Color Reactions with Sulfhydrates. Few drops of FeCl_3 are added to aqueous alcoholic solutions which have been previously mixed with ammonia; methyl, ethyl, amyl, phenyl, tolyl, mercaptans, toluene dimercaptan, thioacetic acid yield reddish brown coloration. Thiolactic and thioglycollic acids give dark reddish violet; metallic thiocyanates, thiosulphates

give dark red, and sulfhydrates of metals of potassium and calcium group form green coloration.

91 Claus, A., and Keerl, D. *B. A.* 1872, 998. *Ber.* 5, 659. Thioisopropyl Alcohol and Isopropylsulfonic Acid. Isopropyl iodide mixed with alcoholic KSH and allowed to stand in cold for some time, then fractionated. Did not get pure because of decomposition and liberation of H_2S . Reacts violently with HNO_3 to form sulfonic acid same as from sulfite. Gives well crystallized salts.

92 Claus, A. *B. A.* 1875, 880. *Ber.* 8, 532. The Sulfur Compounds of the Isopropyl Series. Heat isopropyl iodide with aqueous KSH and some alcohol. Oxidation gives sulfonic acid. Salts have been obtained. Can make cryst. mass by drying over sulfuric acid in vacuum. Oxidize isopropyl sulfide get sulfonic acid also.

93 Dacomo, G. *B. A.* 1892, 306. *Ann. Chim. Farm.* 13, 343-52. *Chem. Zentr.* 1891, ii, 533-4. Metachlorothiophenol. Prepared K, Ba, and Hg salts. Prepared derivatives as acetyl, etc.

94 Dacomo, G. *B. A.* 1892, 306. *Ann. Chim. Farm.* 13, 273-80. *Chem. Zentr.* 1891, ii, 532-3. Dithiocarbonic Acids. Studied reaction between solid KOH and carbon disulfide.

95 Dacomo, G. *B. A.* 1892, 307. *Ann. Chim. Farm.* 14, 1-13. *Chem. Zentr.* 1891, ii, 656-7. Ortho and Para Chlorothiophenol. Prepared disulfides and derivatives.

96 Day, A. W., and Gabriel, S. *B. A.* 1890, 1249. *Ber.* 23, 2478-89. Orthocyanobenzyl Chloride. Prepared thiocyanate mercaptan and disulfide. The cyanide group can be hydrolyzed to the carboxyl.

97 Delepine, M. *C. A.* 1912, 1608. *Ann. Chim. Phys.* 25, 529-74. Physical Properties of Organic Sulfur Compounds.*

98 Delepine, M., and Eschenbrenner, S. *C. A.* 1923, 3161. *Bull. soc. chim.* 33, 703-11. 1,2-Ethylene Sulfides. The properties of $CH_2 \cdot CH_2 \cdot S$, $MeCH \cdot CH_2 \cdot S$, $EtCH \cdot CH_2 \cdot S$ and $Me_2C \cdot CH \cdot Me \cdot S$ are given.

99 Demuth, R., and Meyer, V. *B. A.* 1887, 906. *Ber.* 20, 1830-1. Sulfuranes. Suggested as a name for disulfides described by Mansfield (*B. A.* 1887, 122) and Meyer (*B. A.* 1887, 228). Ethyl sulfurane would be ethyl vinyl ether of ethylene mercaptan. Reactions studied.

100 Deniges, G. *B. A.* 1889, 655. *Compt. rend.* 108, 350-1. Reagents for Mercaptans. Isatin gives test with mercaptans but not sulfides. Sodium nitroprusside also gives tests with mercaptans. See abstract for details.

101 Deuss, J. J. B. *C. A.* 1909, 1746. *Rec. trav. chim.* 28, 136-41. The Action of Aluminum Chloride on Phenyl-disulfide and the Thiocresols, and of Sulfuric Acid on Thianthrene. $AlCl_3$ on $(PhS)_2$ yields thianthrene and PhSH. $AlCl_3$ on thiocresols yields the corresponding disulfides but no methylthianthrene. Fuming sulfuric acid on thianthrene gives the disulfonic acid.

102 Diergart, P. *C. A.* 1920, 935. *J. prakt. Chem.* 99, 281-92. History of Zeise's Mercaptan and its Name (1833). See article.

103 Dobbin, L. *J. Chem. Soc. Trans.* 1890, 639. *Proc. Chem. Soc.* 6, 105. Tertiary Butyl Mercaptan. Tertiary butyl iodide is digested with a sufficient quantity of zinc sulfide to form tertiary butyl mercaptan, b. p. 65°-66°.

104 Dobbin, L. *J. Chem. Soc. Trans.* 1890, 639-43. On Tertiary Butyl Mercaptan. Prepared from zinc sulfide (thoroughly washed to remove ammonium sulfate) and tertiary butyl iodide by heating gently in retort for 2 hours. Distilled completely from a water bath. Distillate collected in a freezing mixture, b. p. 65°-67°. Freezes in snow and salt to white semi-translucent mass. Disagreeable odor. Forms mercuric and silver precipitate. Silver darkens on standing and on boiling forms silver sulfide. Nature of reaction in the preparation discussed.

105 Drummond, A. M., and Gibson, D. T. *C. A.* 1927, 908. *J. Chem. Soc.* 1926, 3073-7. Coordinated Mercaptides. Thiol camphor, Me- β -thiopropionate and Et-thiolicetate and derivatives given.

106 Ebert, R., and Kleiner, E. *B. A.* 1891, 460. *Ber.* 24, 144-7. Naphthylene Dihydrosulfide and Dithiocyanate. The dimercaptan best prepared by reduction of the disulfoxide dissolved in acetic acid with zinc dust. Lead salt with cyanogen chloride forms dithiocyanate.

107 Edinger, A. *B. A.* 1895, i, 300. *J. prakt. Chem.* 1895 [2] 51, 91-6. Sulfides and Hydrosulfides of Aromatic Bases. Quinoline benzyl chloride treated with sodium hydrosulfide gives an unstable mercaptan. When treated with sodium sulfide gives sulfide.

108 Edinger, A. *C. A.* 1908, 1975. *Ber.* 41, 937-43. Benzene-quinolinemercaptan. Red needles, m. p. 58°-59°. $K_4Fe(CN)_6$ yields the disulfide, m. p. 206°. Thiocyanate also given. *o*-Quinolylmercaptan ethyl ether and *ana*-brom-*o*-quinolyl mercaptan given.

109 Edwards, W. F. *B. A.* 1895, ii, 429. *Am. Chem. J.* 17, 473-506. Molecular and Atomic Refraction. Sulfur has 2 values for atomic refraction: one "thiohydroxylsulfur" (-S-) in aliphatic mercaptans and sulfides; and "thiocarbonyl-sulfur" in xanthates and thiocarbonates.

110 Eggers, H. E. *B. A.* 904, ii, 224. *J. Phys. Chem.* 8, 14-36. Dielectric Constants of Solvents and Solutions.

Studied thiocyanates, thiocarbimides, mercaptan, thiophene, ethyl disulfide, thiocetic acid.

111 Egli, K. *B. A.* 1885, 799. *Ber.* 18, 575-7. Dry Distillation of Ammonium Benzenesulfonate.

Forms benzene and a high boiling oil containing benzene, sulfon-amide, diphenyl, phenylsulfide, diphenylsulfone, phenylmercaptan and traces of quinoline.

112 Ehrlich, F. *B. A.* 1902, i, 25. *Ber.* 34, 3366-77. m-Cyanobenzylchloride.

Prepared sulfide, mercaptan, and disulfide of the cyanobenzyl and corresponding carboxylic acids.

113 Erlenmeyer, E. *B. A.* 1903, i, 791. *Ber.* 36, 2720-2. Synthesis of Cystin.

See abstract for synthesis from monobenzoylserin.

114 Erlenmeyer, E. jun., and Stoop, F. *B. A.* 1905, i, 119. *Ann.* 337, 236-63. Synthesis of Serin and Cystin.*

115 Escales, R., and Baumann, E. *B. A.* 1886, 878. *Ber.* 19, 1787-96. Compounds of Phenyl Mercaptan and Ketonic Aldehydes.

Condenses in HCl solution to mercaptal.

116 Ewerlof, F. *B. A.* 1871, 1189. *Ber.* 4, 716. Sulfethers of Ethylene.

Ethylene bromide and sodium mercaptide prepared dimethylthio ether, b. p. 183°, diethyl, b. p. 210°-213° (oxidized to sulfoxide m. p. 170°); diamyl, b. p. 245°-255° (oxidized to sulfoxide m. p. 145°-150°); diphenyl, m. p. 65° (oxid. by chromic acid to sulfoxide) and adds 4 Br probably 2 on each sulfur.

117 Faber, E. M., and Reid, E. E. *C. A.* 1917, 2775. *J. Am. Chem. Soc.* 39, 1930-8. Esterification. IX, The Esterification of Acetic and Propionic Acids by Methyl, Ethyl, Propyl, Isobutyl and Iso-amyl Mercaptans.

Limits of esterification given. These are lower than those for corresponding alcohols. Proportions of reacting substances have but little influence on the limit. Stability of esters decreases with increase in molecular weight.

118 Faragher, W. F., Morrell, J. C., and Comay, S. *C. A.* 1928, 2459. *Ind. Eng. Chem.* 20, 527-32. Thermal Decomposition of Organic Sulfur Compounds.

Results given when solutions of mercaptans, alkyl sulfides and disulfides, thiophene and sulfur in naphtha from Pennsylvania crude oil were subjected to heating at cracking temperature (925° F.).

119 Fasbender, H. *B. A.* 1887, 462. *Ber.* 20, 460-5. Compounds of Aldehyde and Ketones with Mercaptans.

Ethylene dimercaptan and benzaldehyde in an acid solution form mercaptal. Ethylene dimercaptan and bromine form diethylene tetrasulfide. Its isomeric can be prepared by the oxidation of thialdene hydrochloride with iodine.

120 Fasbender, H. *B. A.* 1888, 804. *Ber.* 21, 1473-7. Ethylene Disulfides and Ethylene Disulfones.

Prepared condensation products of ethylene dimercaptan with ethylidene and propylidene and benzylidene. Mercaptals of ethylene dimercaptan. Oxidized to sulfones.

121 Fasbender, H. *B. A.* 1888, 805. *Ber.* 21, 1470-2. Diethylene Tetrasulfide.

Can be prepared from ethylene mercaptan by action of halogens in chloroform solution, by treating mercaptan with concentrated sulfuric acid or sulfuryl chloride, by acting on alkaline solution of mercaptan with hydroxylamine hydrochloride. Forms additive product with bromine.

122 Ferber, E. *C. A.* 1928, 4237. *Z. anorg. Chem.* 41, 680-2. Sulfur Compounds in Transformer Oil.

These compounds were removed with metallic Na, Amyl, heptyl and octyl mercaptans were isolated.

123 Ferran, J. U. *C. A.* 1925, 3477. *Quim. e ind.* 2, 169-70. The Preparation of Ethyl Mercaptan in the Laboratory.

Good yields are obtained only when the K salts are used and the solid EtOSO₄K is added to a highly concentrated solution of KSH, while heat is applied very slowly to 50°.

124 Field, E. *C. A.* 1915, 3228. *J. Chem. Soc.* 107, 1214-7. 3-Thiophenanthrene and Some of its Derivatives.

The method of preparation and its oxidation products and other derivatives given.

125 Finckh, J. *B. A.* 1894, i, 353. *Ber.* 27, 1239-41. Odor of Alkylic Sulfides.

Commercial amyl sulfides heated with powdered Cu for 6-8 hours at 290°-300°, and then fractionated; had an agreeable, sweet, ethereal smell with no change in b. p. Residual Cu contained S and had a garlic odor. On treatment again with Cu no appreciable change on Cu. Ethyl sulfide with 3 fresh portions of Cu still retained trace of its characteristic odor. Methyl sulfide behaved the same. Attempts to deodorize with olive oil, paraffin wax, etc., were unsuccessful. Ethyl mercaptan resembles ethyl sulfide in behavior towards copper, but considerable quantity is decomposed during process.

126 Finger, H., and Hemmeter, O. *C. A.* 1910, 759. *J. prakt. Chem.* 79, 449-50. Action of Aromatic Mercaptides on α -Chloroacetoacetic Ester.

When the latter reacts on PhSNa in alcohol, NaCl separates and the solution becomes yellow-red. With water (PhS)₂ separates. Na-p-tolyl mercaptan yields p-tolyl disulfide. The aqueous solution contains β -diacetosuccinic ester.

127 Finzi, C. *C. A.* 1914, 1757. *Gazz. chim. ital.* 43 (2) 643-54. Action of Phenacyl Bromide on Thioresorcinal.*

128 Finzi, C. *C. A.* 1917, 1160. *Gazz. chim. ital.* 46 (2) 186-203. The Basic Properties of Sulfoxides.*

129 Finzi, C., and Pagliari, E. *C. A.* 1926, 3163. *Gazz. chim. ital.* 56, 331-7. Nitro Derivatives of Esters of Thioresorcinal.*

130 **Fischer, E., and Penzoldt, F. B.A.** 1887, 983. *Ann.* 239, 131-6. Sensitiveness of the Sense of Smell. Mercaptan vapor can be detected 1 part in 50 billion; chlorphenol, 1 part in 1 billion.

131 **Fischer, E. B.A.** 1894, i, 269. *Ber.* 27, 673-9. Compounds of Sugars with Mercaptans. Prepared mercaptals by heating glucose in well cooled HCl (sp. gr. 1.19) Cryst. from ethyl alcohol or water. Does not react with phenylhydrazine, alk. copper. Prepared glucose, galactose, arabinose, mannose, rhamnose and glucoheptose ethyl mercaptals. Gives list of other mercaptals formed with amy1 and benzyl mercaptans and various carbohydrates.

132 **Fischer, E., and Delbrück, K. C.A.** 1909, 2154. *Ber.* 42, 1476-82. Thiophenol Glucosides. Acetobromoglucose in Et_2O is shaken 2 days at ordinary temperature with aqueous solution of NaOH and thiophenol. Bitter taste and stable towards acids.

133 **Fischer, O. B.A.** 1903, i, 52. *Ber.* 35, 3674-83. Action of Phosphorus Pentachloride on 1-Alkylpyridones and 1-Alkylquinolones. Prepared 1-methylthiopyridone methiodide. With sodium hydroxide yields methyl mercaptan.

134 **Fitger, P. C.A.** 1922, 1744. *Ber.* 54B, 2952-63. Some Oxidation Products of Ethyl Mercapto-succinic Acid.*

135 **Fox, J. J., and Pope, F. G. C.A.** 1913, 3317. *J. Chem. Soc.* 103, 1263-6. Absorption Spectra of Some Thio-derivatives of Benzene. Absorption spectra for PhSH , $(\text{PhS})_2$ and Ph_2S in EtOH given.

136 **Fraenkel, N. B.A.** 1885, 1130. *Ber.* 18, 1843-9. Derivatives of Thiodiphenylamine. Prepared by method of Bernthsen (B.A. 1884, 597). It is neutral substance, does not combine with HCl, when heated with zinc-dust or zinc chloride it is partly recovered into diphenylamine. Derivatives prepared.

137 **Frassetti, P. B.A.** 1905, i, 256. *Ber.* 38, 488-92. Ethylene Xanthate and Ethylene Thiocarbonate. Alcoholic potash converts ethylene xanthate into ethylene thiocarbonate and ethyl alcohol. Yield good. With more alkali ethylene hydrosulfide is formed.

138 **Frerichs, F. B.A.** 1874, 990. *Ber.* 7, 792-5. Thiohydrobenzoic Acid, Di-thiobenzoic Acid and Bromothiohydrobenzoic Acid. Can sublime thiobenzoic acids in CO_2 . Forms Ba, Cu, Ag, Pb and Hg salts. Salts part on SH and part on COOH groups.

139 **Fricke, R., and Spilker, G. C.A.** 1925, 1412. *Ber.* 58B, 24-6. Preparation of o-Ethylthiophenol by Hydrogenation of Thionaphthene. Thionaphthene in boiling alcohol with Na gives o-ethylthiophenol. Pb and Hg salts and Me ether given.

140 **Fricke, R., and Spilker, G. C.A.** 1926, 193. *Ber.* 58B, 1589-601. The (Non-catalytic) Hydrogenation of Thionaphthene.*

141 **Fricke, R., and Spilker, G. C.A.** 1926, 1804. *Ber.* 59B, 349. Hydrogenation of Thionaphthene. An addendum. A number of physical constants were omitted in the original papers (C.A. 1926, 193).

142 **Friedmann, E. B.A.** 1902, i, 731. *Beitr. chem. Physiol. Path.* 2, 433-4. The Constitution of Proteid Cystine. Compare protein cystine with synthetic.

143 **Friedmann, E. B.A.** 1903, i, 75. *Beitr. Chem. Physiol. Path.* 3, 1-46. Physiological Relations of Derivatives of Proteids Containing Sulfur. I, Constitution of Cystine. Gives good summary of the relationship of cystine, cysteine, and taurine. Discusses the origin and fate of cystine in the organism.

144 **Friedmann, E. B.A.** 1903, i, 301. *Beitr. chem. Physiol. Path.* 3, 184-92. Physiological Relations of Derivatives of Proteids Containing Sulfur. II, α -Thiolactic Acid, a Decomposition Product of Keratin-Substance. Studied thiolactic acids from different sources.

145 **Friedel and Ladenburg. B.A.** 1873, 53. *Ann. chim. phys.* [4] 27, 416-28. A Silicic Mercaptan and a Silicic Chlorobromide. Prepared SiCl_3SH , b.p. 95°-97°. With EtOH forms $\text{SiSH}(\text{OC}_2\text{H}_5)_3$ but excess gives $\text{Si}(\text{OEt})_3$. Bromine forms SiCl_3Br . States that EtSH and bromine gives EtBr and SBr and HBr .

146 **Friedlander, P., and Lenk, E. C.A.** 1912, 2923. *Ber.* 45, 2083-90. o- and p-Mercaptobenzaldehydes. Various derivatives are described.

147 **Fries, K., and Volk, W. C.A.** 1909, 2131. *Ber.* 42, 1170-6. Thianthrene. Thiophenols and concentrated sulfuric acid containing SO_2 yield SO_2 and disulfides. Further action of the acid yields thianthrene. Dimethyl thianthrene formed similarly. Dilute HNO_3 converts latter into monosulfoxide and disulfoxide. Naphthanthrene also formed.

148 **Fries, K., and Engelbertz, E. C.A.** 1915, 785. *Ann.* 407, 194-228. Thianthrene. Study of simple thianthrene is extended. The 3,7-dimethoxy and 3,7-dihydroxy derivatives are given and their various derivatives and oxidation products.

149 **Frohlich, J. C.A.** 1907, 2579. *Ber.* 40, 2489-92. Synthesis of Unsymmetrical Substituted Thianthrenes. Formed by action of picryl chloride on disodium salt of 1-methyl-2-amino-4, 5-phenyldithiol, azo- and other derivatives made.

150 **Fromm, E., and Junius, E. B.A.** 1895, i, 418. *Ber.* 28, 1102-13. Con-

densation of Methylphenyldithiobiuret with Aldehydes and Ketones.

Benzyl mercaptan reacts more rapidly with benzaldehyde than it does with acetones to form mercaptal.

151 Fromm, E., and Gómez, D. von. C. A. 1908, 127. Ann. 355, 196-215. Derivatives of Persulfocyanic Acid and of Cyanaminodithiocarbonic Acid. Synthesis of New Triazoles.
With NH_2HS yields benzylmercaptan and benzyltrithioallophanate. Easily oxidized by air. Heating also splits off benzylmercaptan.

152 Fromm, E., and Erfurt, F. C. A. 1910, 212. Ber. 42, 3816-22. Fission of Thiosulfates and Thiosulfonates by Means of Alkali.
The products of the interaction of NaOH and $\text{NaEt}_2\text{S}_2\text{O}_3$ are $\text{Na}_2\text{S}_2\text{O}_3$, ethyl sulfenic acid, and EtSSEt . Similar products obtained from Na benzylthiosulfate and Na p-toluenethiosulfonate.

153 Fromm, E., and Erfurt, F. C. A. 1910, 212. Ber. 42, 3808-12. Benzylsulfoxide and α -Hydroxybenzyl Sulfide.
 α -Hydroxybenzyl sulfide from benzylmercaptan and BzH . Extremely unstable and is converted by warming in benzene to benzylbenzomercaptal. Results show α -hydroxybenzylsulfide not tautomeric with benzylsulfoxide.

154 Fromm, E., Benzinger, H., and Schäfer, F. C. A. 1913, 1001. Ann. 394, 325-37. Derivatives of Ethyl Mercaptan, Dithioethylene, and Dithioacetylene.
Numerous derivatives of these compounds given. See abstract.

155 Fromm, E., Forster, A., and Scher-schewitzki, B. von. C. A. 1913, 1002. Ann. 394, 343-9. Some Mercaptals and Mercaptoles and their Derivatives.
Formaldehyde benzylmercaptal, acetaldehyde benzylmercaptal, acetone benzylmercaptole, formaldehyde p-tolylmercaptal, acetone p-tolylmercaptole, di-p-tolylsulfoneemethylmethane and di-p-tolylsulfoneethylmethane given and their action with H_2O_2 and KMnO_4 .

156 Fromm, E., and Forster, A. C. A. 1913, 1002. Ann. 394, 338-43. Cleavage of Benzyl Disulfide with Alkali.
In addition to PhCH_2SH and BzOH , $(\text{PhCH}_2\text{S})_2$ and BzSH in boiling alcohol yield PhCS_2H and BzSH . Sulfur acids on standing in air oxidized to disulfides. Boiling sulfur acids with PhCH_2Cl and alc. alkali converts them into esters.

157 Fromm, E., and Siebert, E. C. A. 1922, 3630. Ber. 55B, 1014-30. Derivatives of Dithioethylene and Dithioacetylene and the Power of Addition of Multiple Bonds.*

158 Fromm, E., and Landmann, H. C. A. 1924, 1113. Ber. 56B, 2290-4. Derivatives of Dithioethylene and Dithioacetylene.*

159 Fromm, E., and Augar, B. C. A. 1924, 1112. Ber. 56B, 2286-9. Deriva-

tives of Thiodiglycol, Diethylene Sulfide and Thioxan.*

160 Fromm, E., Kapeller, R., and Taubmann, I. C. A. 1928, 4468. Ber. 61B, 1353-8. Sulfur-containing Derivatives of Glycol.*

161 Gabriel, S. B. A. 1877, ii, 311. Ber. 10, 185. Orthothioformic Ethers.
Sodium phenylmercaptide heated with chloroform yields phenylthioformate. Corresponding ethyl derivative formed. Fuming hydrochloric acid resolves it into mercaptan and formic acid.

162 Gabriel, S., and Deutsch, A. B. A. 1880, 476. Ber. 13, 386-91. Sulfur Derivatives of Diphenyl.
Prepared sulfonic chloride, monosulfamide, mercaptan, sulfide (by dry distillation of lead mercaptide) sulfone, disulfide sulfenic acid, ethyl sulfonate and sulfacetic acid. Prepared from disulfonic acid, the chloride, amide, mercaptan and sulfatic acid.

163 Gabriel, S., and Dambergis, A. K. B. A. 1880, 890. Ber. 13, 1408-12. Nitro Derivatives of Diphenyl Mono- and Di-sulfonic Acids.
Prepared mercaptans of diphenyl with one amino group on ring.

164 Gabriel, S. B. A. 1891, 815. Ber. 24, 1110-21. Derivatives of Ethylamine.
Prepared ethylene amidomercaptophydrochloride and the corresponding sulfide. Derivatives prepared.

165 Gabriel, S. B. A. 1892, 130. Ber. 24, 3098-3104. Thioderivatives of Ethylamine.
The action of various substances on ethylmercaptophthalimide has been studied. Formation of sulfide, sulfoxide, and sulfone.

166 Gabriel, S., and Pinkus, G. B. A. 1893, i, 734. Ber. 26, 2197-2209. Amido ketones.
Preparation of methylamidazolyl- μ -mercaptan given. On oxidation loses the SH group to form methylimidazole.

167 Gabriel, S., and Stelzner, R. B. A. 1896, i, 215. Ber. 29, 160-5. Orthonitrobenzylmercaptan.
Gives preparation from orthonitrobenzylcarbiminthiolate. Sulfides prepared.

168 Gabriel, S., and Leupold, E. B. A. 1898, i, 121. Ber. 31, 2646-54. Action of Potassium Hydrosulfide on Orthocyanobenzyl Chloride.
Probably a mercaptan first is formed which then forms ring compounds.

169 Gattermann, L. C. A. 1913, 604. Ann. 393, 113-97. Mercaptans of Anthraquinone. I.
Many compounds and their properties given. See abstract.

170 Gebauer-Fulnegg, E. C. A. 1927, 1974. J. Am. Chem. Soc. 49, 1386-7. Aluminum Amalgam as an Agent for the Reduction of Phenyl Sulfone Chlorides to Thiophenols.
Yields vary from 50% to 70% of the theory.

171 Geuther, A. *B.A.* 1884, 54. *Ann. 221*, 55-59. Action of Phosphorus Trisulfide on Phenols.
Forms benzene, triphenyl phosphate, with traces of mercaptan and sulfide; while the pentasulfide gives thiophenol and hydrogen sulfide.

172 Gibson, D. T., and Smiles, S. *C.A.* 1924, 57. *J. Chem. Soc.* 123, 2388-93. Derivatives of o-Thiophenols.*

173 Gibson, D. T., Miller, C. J., and Smiles, S. *C.A.* 1925, 3259. *J. Chem. Soc.* 127, 1821-4. Synthesis of Disulfonides.
R'SH in C_6H_6 containing a small amount of C_5H_5N when added to a boiling solution of excess of RSO_2Cl gives disulfoxides.

174 Gilfillan, F. A. *C.A.* 1922, 2304. *J. Am. Chem. Soc.* 44, 1323-33. Catalysis. II, Dehydration and Addition Reactions of Ethyl Alcohol; Formation of Acetal and Mercaptans.
In presence of any of 3 metallic oxides mixtures of $EtOH$ and CS_2 give considerable $EtSH$, TiO_2 proving to be the best catalyst for this reaction.

175 Gilman, H., and Beaber, N. J. *C.A.* 1925, 1850. *J. Am. Chem. Soc.* 47, 1149-51. Alkylation of Mercaptans by Means of Sulfonic Esters.
RSH may be alkylated in good yields by refluxing an alkaline solution with an equiv. quantity of R_2SO_4 . Various sulfides and sulfones were prepared.

176 Gilman, H., Robinson, J., and Beaber, N. J. *C.A.* 1926, 3693. *J. Am. Chem. Soc.* 48, 2715. Reaction Between Organo-magnesium Halides and the Esters of Some Sulfur Acids.
No alkylating action observed in the reactions between $RMgX$ and the esters of SO_2H , SOH , $COSH$, $CSOH$ and CS_2H acids.

177 Ginsbury, J., and Bondzynski, S. *B.A.* 1886, 325. *Ber.* 19, 113-24. Rhodanic Acid.
Continues work of Nencki and Bourquin (*B.A.* 1885, 40) studying the non-nitrogenous acid formed by the action of alkalies on rhodanic acid and also the condensation products of rhodanic acid with benzaldehyde. Found thioglycolic acid and hydrothiocinnamic acid.

178 Giua, M., and Ruggeri, A. *C.A.* 1924, 235. *Gazz. chim. ital.* 53, 341-5. A New Method of Preparation of Some Aromatic Sulfides, II.
The compounds are prepared by the use of thiourea.

179 Grabowsky, N. *B.A.* 1875, 881. *Ann. 175*, 344-8. Normal Sulfobutyric Acid and Its Salts.
Prepared sulfonic acid from n-butyl mercaptan by dropping slowly into 1.3 nitric acid. Prepared Na, Ba, Ca, Pb, Cu, Ag salts.

180 Grabowsky, N. *B.A.* 1875, 1175. *Ber.* 7, 1650; *Chem. Zentr.* 1875, 51. Normal Sulfobutyric Acid and Its Salts.
Oxidizes mercaptan to sulfonic acid with nitric acid. Sulfide is oxidized to sulfoxide (conc. acid) and sulfone (fuming acid).

181 Graebe, C. *B.A.* 1876, i, 578. *Ann. 179*, 178-83. Diphenylene Disulfide.
Two parts phenol heated with 1 part of phosphorus pentasulfide forms phenyl mercaptan. At higher temperatures benzene, sulfophenol, and diphenylene disulfide are chief products. Gives properties of diphenylene disulfide. Oxidized to disulfone which is exceedingly stable.

182 Graebe, C., and Schultess, O. *B.A.* 1891, 1058. *Ann.* 263, 1-15. Thioxanthone.
Can be prepared from phenylthiosalicylic acid heated at 100° with concentrated sulfuric acid. Can be oxidized to sulfone, reduced to methane, and methane oxidized to sulfone.

183 Gray, H. L., and Gutekunst, G. O. *C.A.* 1920, 1829. *J. Am. Chem. Soc.* 42, 856-60. Sulfur Derivatives of Butyl Alcohol
Butyl sulfide, mercaptan, ether and $NaBuSO_4$ were prepared.

184 Grosjean, L. *B.A.* 1890, 1306. *Ber.* 23, 2370-1. *a*, *a*-Dithionaphthol.
Prepared by reduction of the sulfon-chloride.

185 Groth, B. *C.A.* 1924, 1280. *Arkiv. Kemi Mineral Geol.* 9, No. 1, 63 p. Phenacyl Mercaptan and Related Compounds.
Many compounds and their constants are given. See abstract.

186 Gutmann, A. *C.A.* 1908, 2374. *Ber.* 41, 1650-5. Action of Alkali Hydroxides on Ethyl Sodium Thiosulfate, II.
Ethyl sodium thiosulfate warmed with $EtOH$ and KOH precipitates $KNaSO_3$. The solution contains a compound $EtSOH$ which reacts with Na_2AsO_3 to form $EtSH$. With KNC and Na_2S , $EtSH$ is formed.

187 Gutmann, A. *C.A.* 1927, 2659. *Z. anal. Chem.* 71, 43-5. Perchloromethyl Mercaptan.*

188 Hagelberg, L. *B.A.* 1890, 949. *Ber.* 23, 1083-92. Thiocyano- and Selenocyanogeno-derivatives.
Trimethylene dithiocyanate is prepared from trimethylene bromide. Treated with alcoholic potash forms disulfide. Dimercaptan by reducing thiocyanate with zinc and HCl. See abstract or original.

189 Heffter, W. *B.A.* 1895, i, 671. *Ber.* 28, 2258-64. Derivatives of Anthracene β -Sulfonic Acid and Anthracyl Hydro-sulfide.
Prepared anthracene β -sulfonic chloride, sulfonamide, anilide, dimethyl anilide, phenylhydrazide, methyl sulfonate, sulfonic acid and mercaptan.

190 Herrmann, F. *B.A.* 1905, i, 733. *Ber.* 38, 2813-25. Compounds of Gold with Organic Sulfur Groups.
 $AuCl_3$ and RSH form $AuSR$ and disulfide. Aurous and auric compound studied.

191 Hesse, C. *B.A.* 1881, 596. *Ber.* 14, 488-96. Amidotoluenesulfhydrates.
Reduce sulfonchloride with tin and hydrochloric acid.

192 **Hilditch, T. P. C.A. 1912, 756.** *Ber.* 44, 3583-9. Intramolecular Rearrangement of Aliphatic Sulfoxides.
With dry HCl in abs. alc. or with Ac_2O , diisoamylsulfoxide gives isoamylmercaptan and isovaleraldehyde.

193 **Hinsberg, O. B.A. 1906, i, 654.** *Ber.* 39, 2427-36. Isomerism of Ar-thioccompounds.*

194 **Hinsberg, O. C.A. 1907, 725.** *Ber.* 39, 4331-2. Note on the Reactions of Dinitrophenyl Sulfocyanate.
Concentrated sulfuric acid converts this compound into 2,4-dinitrophenyl mercaptan and 2,4'-tetranitrodiphenylsulfide, the latter in greater quantity.

195 **Hodgson, H. H., and Handley, F. W. C.A. 1928, 950.** *J. Soc. Chem. Ind.* 46 435-6T. A Method for Direct Methylthiolation and its Application in the Separation of Some Substituted Thionanisoles.
Reaction brought about by action of alkali and MeSH on chloronitro-benzenes.

196 **Hoffman, A. W. B.A. 1871, 394.** *Ber.* 4, 246-51. On Isodicyanic Ethers, Compounds Intermediate Between Cyanic and Cyanuric Ethers.
Phenylcyanate reacts with amyl mercaptan when heated forming a new substance whose constitution is not given.

197 **Hoffman, W. S., and Reid, E. E. C.A. 1923, 3338.** *J. Am. Chem. Soc.* 45, 1831-8. Derivatives of Anthraquinone—Reactions of Anthraquinonesulfonic Acids with Mercaptans.
Derivatives of many mercaptans and their constants are given.

198 **Hofman, A. W. B.A. 1880, 797.** *Ber.* 13, 1349-52. Transformation of Methyl Thiocyanate at High Temperatures.
When methyl thiocyanate is heated at 180°-185° for 6 hours partly polymerised. Hot HCl splits the compound to methyl mercaptan and cyanic acid.

199 **Holmberg, B. C.A. 1908, 1690.** *Ann.* 359, 81-99. Organic Polysulfides.
 EtSH dissolved in alkali and S added was oxidized to EtSSEt . Thioglycollic acid behaved similarly. PhSH could be oxidized to disulfide if an alkali tetrasulfide was present. EtSSEt , S and dry NH_3 in alcohol gave polysulfide, EtSH and S_2Cl_2 containing Cl. In ether gave mono-, di- and tri-sulfides. Thioglycollic acid acted similarly. SOCl_2 and EtSH reacted quantitatively as follows, $4 \text{ RSH} + \text{SOCl}_2 \rightarrow \text{R}_2\text{S}_2 + \text{R}_2\text{S}_3 + \text{H}_2 + 2\text{HCl}$. SO_2Cl_2 oxidizes mercaptans.

200 **Holmberg, B. C.A. 1910, 1047.** *Ber.* 43, 226-7. p-Tolyl Trisulfide.
Thionyl aniline and p-tolylmercaptan when heated give a liquid containing PhNH_2 and a solid consisting of p-tolyl trisulfide.

201 **Hubner and Upmann, U. B.A. 1871, 371.** *Z. f. Chem. [2]* 6, 294. On Thiohydrobenzoic Acid—Preliminary Notice.

202 **Hubner, H., and Post, J. B.A. 1874, 56-61.** *Ann. Chem. Pharm.* 169, 1-69. Bromtoluenes.
 β -Paratolylsulhydrate forms bright brick red lead salt which readily absorbs oxygen and becomes white. o-Bromotolyl sulhydrate lead salt yellow precipitate. Dilute nitric acid forms disulfide. Metatolylsulhydrate attacks the skin. Boiling dilute nitric converts it into disulfide.

203 **Huebner, H., and Mueller, F. C. G. B.A. 1871, 120.** *Z. f. Chem. [2]* 7, 14. On a Sulfotoluene Derived from Bromosulfotoluene.
Toluene sulfochloride reduced by tin and HCl to the mercaptan. Very caustic, destroying the skin. Forms mercaptides with metals. Mercaptan boiled for some days with dilute HNO_3 forms disulfide (b. p. 150° with partial decomposition).

204 **Hunter, R. F. C.A. 1925, 2052.** *J. Chem. Soc.* 127, 911. Physiological Action of Certain Benzothiazoles and Mercaptan Derivatives.
Hot solutions of dehydrothiolutidine in contact with skin develop a form of eczema. Related sulfur compounds act similarly. Bathing the skin with warm water relieves irritation and treatment with a 2% PhOH has a beneficial action.

205 **Hurtley, W. R. H., and Smiles, S. C.A. 1926, 3289.** *J. Chem. Soc.* 1926, 1821-8. o-Dithiobenzene.
Its preparation and various derivatives given.

206 **Jackson, C. L., and White, J. F. B.A. 1881, 806.** *Am. Chem. J.* 2, 158-72. Parachlorobenzyl Compounds.
Prepared parachlorobenzyl sulfonic acid, salts of it, chloride, sulfide, sulfone, mercaptan, disulfide, disulfodioxide.

207 **Jacobson, P. B.A. 1887, 961.** *Ber.* 20, 1895-1903. Orthoamidated Aromatic Mercaptans.*

208 **Jacobson, P., and Ney, E. B.A. 1889, 771.** *Ber.* 22, 904-11. Aromatic Orthamidomercaptans.
Prepared mercaptans and disulfides of substituted aromatic nucleus. Gives ditoluylene and dixlylyene disulfides.

209 **Johnson, T. B., and Storey, W. F. C.A. 1909, 50.** *Am. Chem. J.* 40, 131-47. The Action of Potassium Thiocyanate on Some Imide Chlorides.
In certain cases when KSCN reacts on chloropyrimidines the intermediate thioevanate can be isolated, mercapto-thiocyanate compounds being obtained.

210 **Jones, H. O., and Tasker, H. S. C.A. 1910, 1023.** *J. Chem. Soc.* 95, 1904-9. Action of Mercaptans on Acid Chlorides, I, Oxalyl Chloride; the Mono- and Dithio-oxalates.
Two mol. of phenylmercaptan and 1 mol. of oxalyl chloride yield phenyl dithio oxalate. The methyl, ethyl, propyl, and isoamyl esters were prepared similarly.

211 **Kahan, M. B.A. 1897, i, 494.** *Ber.* 30, 1318-26. Diacetonealkamine.
Prepared amidohexene sulfonic acid.

212 Kehrmann, F., and Duttenhofer, A. B.A. 1906, i, 949. *Ber.* 39, 3559-60. Aromatic Sulfine Bases. Prepared from aromatic mercaptans and excess methyl sulfate at 100°. See abstract for those prepared.

213 Kimball, J. W., and Reid, E. E. C.A. 1917, 338. *J. Am. Chem. Soc.* 38, 2757-68. VII. Esterification of Benzoic Acid by Isomeric Butyl Mercaptans. Rates and limits for normal and isomercaptans nearly the same, those for secondary much lower. These limits much lower than those for corresponding alcohols. The limits independent of relative amounts of acid and mercaptan present.

214 Kimball, J. W., Kramer, R. L., and Reid, E. E. C.A. 1921, 2881. *J. Am. Chem. Soc.* 43, 1199-1200. Iodometric Estimation of Mercaptans. A modification of Klason and Carlson's method (*Ber.* 39, 438).

215 Klason, P. B.A. 1888, 356. *Ber.* 20, 3407-13. Preparation of Hydrosulfides and Sulfides of Methyl and Ethyl. Prepared methyl mercaptan and a large number of mercaptides. Also ethyl mercaptan and mercaptides. Methyl and ethyl sulfides prepared (150 g. or more each). Forms Cu(SEt) not Cu(SEt)₂.

216 Klason, P. B.A. 1903, i, 224. *J. prakt. Chem.* [2] 67, 1-40. Constitution of Platinum Bases. Ethyl mercaptan on ammonium platosemiarnine chloride yields a substance which when boiled with HCl yields EtS · PtCl which with ammonia forms EtS · PtNH₂Cl. Thiophenol on platoammine hydroxide yields phenyl mercaptide Pt(NH₂Ph)₂. See abstract.

217 Klason, P., and Carlson, T. B.A. 1906, i, 232. *Ber.* 39, 732-8. Thioglycolic Acid. Yield from chloracetic acid and KSH is better in dilute solution. Derivatives prepared.

218 Klason, P., and Carlson, T. B.A. 1906, i, 787. *Ber.* 39, 2752-4. Organic Nitrates. On hydrolysis alkyl peroxide is shown by oxidation of mercaptan to disulfide.

219 Klason, P., and Carlson, T. B.A. 1907, i, 1000. *Ber.* 40, 4183-91. The Alkaline Hydrolysis of Alkyl Nitrates; a Contribution to the Constitution of Nitric Acid. See *B. A.* 1906, i, 787. Presence of phenyl mercaptan during hydrolysis of alkyl nitrates prevents formation of resin. See abstract.

220 Knoll, R. C.A. 1926, 2669. *J. prakt. Chem.* 113, 40-5. Oxidation of Sulfides to Sulfoxides. CrO₃ in 80% AcOH on sulfides yields in all cases examined only the sulfoxide, while H₂O₂ either does not act at all, or forms the sulfone.

221 Koenigs, E., and Kinne, G. C.A. 1921, 3842. *Ber.* 54B, 1357-62. γ -Pyridyl Mercaptan and γ -Pyridine Sulfonic Acid.

γ -Pyridyl mercaptan prepared by action of KSH in dilute alc. on γ -C₆H₄NCl 6 hours, in sealed tube at 140°. Forms the disulfide and certain salts.

222 Kohn, H. C.A. 1924, 1467. *Bul. Soc. chim. România* 5, 70-2. Octyl Mercaptan. B. p. 198°-200°, disagreeable odor, decomposed on warming to octyl sulfide and H₂S. Forms with alc. HgCl₂ a white precipitate very difficult to dissolve in acids.

223 Kolbe, H. B.A. 1872, 224. *J. prakt. Chem.* [2] 4, 412-7. Decomposition of the Soluble Metallic Sulfides by Water. Discusses the action of sodium sulfide when boiled with potassium ethyl sulfate. More dilute sodium sulfide, more mercaptan. Concentrated sodium sulfide, mostly ethyl sulfide. Discusses whether sodium sulfide hydrolyzes to sulfhydrate or stays as sulfide.

224 Kotz, A. B.A. 1900, i, 343. *Ber.* 33, 729-30. Xylylene Hydrosulfides. Prepared by the action of alcoholic KSH on the corresponding bromide. React with methylene iodide to form mercaptals.

225 Kotz, A., and Sevin, O. B.A. 1902, i, 172. *J. prakt. Chem.* [2] 64, 518-29. Heterocyclic Compounds. Prepared xylylene disulfide and dimercaptan. Prepared from dimercaptan compounds with methylene, ethylene, trimethylene and p-xylylene bromide. Prepared o-, m-, and p-xylylene dimercaptan.

226 Krafft, F., and Schonherr, R. B.A. 1889, 715. *Ber.* 22, 821-26. Thionaphthols. Gives preparation from sulfonate.

227 Krafft, F. B.A. 1874, 806. *Ber.* 7, 384-5. On Thiobenzene and Thioaniline. Preparation of phenylsulfide from thioaniline by diazo reaction.

228 Kramer, R. L., and Reid, E. E. C.A. 1921, 1720. *J. Am. Chem. Soc.* 43, 880-90. Catalytic Preparation of Mercaptans. See abstract for method of using pumice coated with thoria, alcohol and H₂S.

229 Krishna, S. C.A. 1923, 1448. *J. Chem. Soc.* 123, 156-60. Synthesis of Substituted Thianthrenes. I, Thianthrene and Nitrothianthrene. Various derivatives of thianthrene given.

230 Krishna, S. C.A. 1924, 385. *J. Chem. Soc.* 123, 2786-90. Synthesis of Substituted Thianthrenes, II. 3-Nitro-6-methylthianthrene, 3-nitro-6,8-dimethylthianthrene, 3-nitro-8-methoxy-5-methylthianthrene and 6-chloro-3-nitrothianthrene are given.

231 Krishna, S., and Singh, S. C.A. 1928, 1150. *Quart. J. Indian Chem. Soc.* 4, 291-6. Action of Carbon Tetrachloride on Certain Mercaptans. 12 g. PhSH heated 24 hours in sealed tube at 110° with 17 g. CCl₄ and 36 g. KOH in a little water, gave 12% o-HSC₆H₄COOH and much (PhS)₂. Other compounds given.

232 **Kruger, M. C. A.** 1923, 1470. *Ber.* 56B, 480-8. Benzopyrone Sulfonic Acids and Coumarin Mercaptans. Various derivatives given.

233 **Larsson, E. C. A.** 1928, 4469. *Svensk. Kem. Tid.* 40, 149-50. Preparation of Thioglycollic and Thiolactic Acids by Electro-reduction. See abstract for procedure.

234 **Lawrence, W. T. B. A.** 1896, i, 272. *Ber.* 29, 547-52. Compounds of Sugars with Ethylene Mercaptan, Trimethylene Mercaptan and Benzyl Mercaptan. See abstract for constants of mercaptals formed.

235 **Lecher, H. C. A.** 1915, 3241. *Ber.* 48, 1425-32. Valence of Sulfur. II, Thiophenolmercury (Mercuric Thiophenolate). Author gives series of reactions to test further the correctness of the theory that change in color observed on heating certain sulfur compounds is due to gradual weakening of S-S union. See abstract.

236 **Lecher, H. C. A.** 1920, 3080. *Ber.* 53B, 591-3. A Reduction of Organic Disulfides by Alkali Mercaptides.*

237 **Lecher, H., and Simon, K. C. A.** 1923, 739. *Ber.* 55B, 2423-32. Valence Problem of Sulfur. VII, o-Nitro-phenyl Dithiochloride.*

238 **Lecher, H., Holschneider, F., Koberle, K., Speer, W., and Stocklin, P. C. A.** 1925, 1855. *Ber.* 58B, 409-16. Phenyl Sulfur Chloride.*

239 **Lecher, H., and Seifken, W. C. A.** 1926, 2976. *Ber.* 59B, 1314-21. Nitro-syl Derivatives of Bivalent Sulfur.*

240 **Lecher, H., and Siefken, W. C. A.** 1927, 890. *Ber.* 59B, 2594-2601. Nitro-syl Derivatives of Bivalent Sulfur. II, Nitro-syl Ethyl Mercaptide. The mechanism of the reaction further discussed.

241 **Lehman, M. B. A.** 1894, i, 567. *Ber.* 27, 2172-77. Sulfur Derivatives of Propylamine. Different derivatives of propylamine as mercaptan, disulfide, and sulfide given.

242 **Leuckart, R. B. A.** 1890, 603. *J. prakt. Chem.* [2] 41, 179-224. Aromatic Mercaptans. Preparing by acting on the diazo-aromatic compounds with potassium ethyl xanthate and decomposing the compound thus obtained with caustic alkali. Prepared mercaptans, sulfides, disulfides.

243 **Levene, P. A., and Mikeska, L. A. C. A.** 1926, 577. *J. Biol. Chem.* 65, 515-8. Oxidation of Secondary Mercaptans into Corresponding Sulfonic Acids. Converted into sulfonic acids by KMnO_4 .

244 **Levi, G. R. C. A.** 1925, 1556. *Atti. Congresso naz. chim. ind.* 1924, 373-5.

A Practical Method for the Preparation of Mercaptans and Alkyl Sulfides. Process is based on the following reactions:

$$3 \text{ ROH} + \text{Al}_2\text{S}_3 = 3\text{ RSH} + \text{Al}_2\text{O}_3$$

$$3 \text{ RR}'\text{O} + \text{Al}_2\text{S}_3 = 3\text{ RR}'\text{S} + \text{Al}_2\text{O}_3$$

245 **Levi, G., and Natta, G. C. A.** 1925, 2190. *Gazz. chim. ital.* 54, 973-7. The Action of Aluminum Sulfide on Some Organic Compounds. At $260^\circ\text{-}310^\circ$ EtSH and Et_2S were obtained when Al_2S_3 was allowed to react with EtOH.

246 **Llaguet, B. B. A.** 1900, i, 503. *Bull. soc. chim.* [3] 23, 507-9. Action of Ethyl Mercaptan on Some Diatomic Ketones. Formation of mercaptals.

247 **Loven, J. M. B. A.** 1884, 1298. *J. prakt. Chem.* [2] 29, 366-78. Thiolactic and Thiodilactic Acids. Prepares α - and β -thiolactic and dithiodilactic acids.

248 **Loven, J. M. C. A.** 1909, 73. *J. prakt. Chem.* 78, 63-73. Optically Active Thiolactic and Thiodilactic Acids. Trithiolactic acid yielded α -thiolactic acid by action of FeCl_3 on former. Latter resolved into the optically active dithiolactic acids by fractional crystallization from α -, or 1-phenylethyl amine.

249 **Lowry, T. M., and Donington, D. C. J. Chem. Soc. Trans.** 1903, 479-84. Camphor β -thiol. Prepared by reducing sulfochloride. Prepared derivatives.

250 **Lustig, G. B. A.** 1891, 1350. *Gazz. chim. ital.* 21, 213-6. Synthesis of Aromatic Compounds. Prepared from potassium ethyl xanthate and diazo compounds. See Leuckart (B. A. 1890, 603).

251 **McKibben, M., and McClelland, E. W. C. A.** 1923, 1450. *J. Chem. Soc.* 123, 170-3. Production and Reactions of 2-Dithiobenzoyl. Its preparation and action with FeCl_3 and O given.

252 **Mailhe, A., and Murat, M. C. A.** 1910, 2297. *Bull. soc. chim.* 7, 288-91. Action of Sulfur and of Selenium on Cyclohexylmagnesium Chloride. Precipitated S reacts easily to give the corresponding mercaptan. Oxidized by HNO_3 , chromic acid, or Na and I to disulfide. Se acts less easily to form the selenide.

253 **Mailhe, A. C. A.** 1921, 3201. *J. usines gaz.* 45, 209-12. Sulfur Compounds in Coal Tar. CH_3SH , $\text{C}_6\text{H}_5\text{SH}$, $(\text{CH}_3)_2\text{S}$, $(\text{C}_2\text{H}_5)_2\text{S}$, thiophene and its derivatives, and thionaphthene.

254 **Maly, R., and Andreasch, R. B. A.** 1881, 630. *Ber.* 13, 601-7. Nitroso-thioglycolic Acid. Prepared from nitrosothiohydantoin. Gives blue color with ferric chloride.

255 **Manasse, A. B.A.** 1902, i, 351. *Ber.* 35, 1367-72. Synthesis of ξ -Aminoheptoic Acid. Prepared ϵ -phthaliminoamyl mercaptan disulfide and sulfide.

256 **Manchot, W., and Krische, P. B.A.** 1905, i, 142. *Ann.* 337, 170-204. Action of Ammonium Sulfide on Ketones and Conversion of Thiopinacones into Hydrocarbons.*

257 **Manchot, W., and Zahn, C. B.A.** 1906, i, 752. *Ann.* 345, 315-34. Thioderivatives of Aromatic Aldehydes and Ketones and their Desulfurization.*

258 **Marckwald, W., Klemm, W., and Trabert, H. B.A.** 1900, i, 456. *Ber.* 33, 1556-66. Pyridine Series, II. Prepared 2-pyridyl mercaptan from 2-chloropyridine. Forms cuprous salt. Methyl iodide converts it into sulfide. Oxidized to sulfone. Prepared disulfide and pyridyl 2-thioglycolic acid. Also prepared compounds from lutidine.

259 **Mayer, F. C.A.** 1909, 2945. *Ber.* 42, 3046-67. Derivatives of Thiosalicylic Acid and of Thioxanthone. Esters, sulfones, nitro derivatives and acyl derivatives, all given. Many compounds given.

260 **Merezhkovskii, B. K. C.A.** 1915, 1899. *J. Russ. Phys. Chem. Soc.* 46, 1082-4. New General Method of Formation of Mercaptans. General method based on following reactions:

$$3 \text{ ROH} + 3 \text{ BrP} = 3 \text{ RBr} + \text{P(OH)}_3$$

$$4 \text{ P(OH)}_3 + \text{Na}_2\text{SO}_4 = \text{Na}_2\text{S} + 4 \text{ H}_3\text{PO}_4$$

$$\text{Na}_2\text{S} + \text{H}_3\text{PO}_4 = \text{Na}_2\text{HPO}_4 + \text{H}_2\text{S}$$

$$\text{RBr} + \text{H}_2\text{S} = \text{RSH} + \text{HBr}$$

261 **Meyer, V. B.A.** 1887, 228. *Ber.* 19, 3259-66. Thiodiglycol-compounds. Thiodiglycol is obtained by treating a concentrated aqueous solution of potassium sulfide with glycol chlorhydrin. Prepared the chloroderivative or mustard gas. Very poisonous. Prepared ethylene dimercaptide from the bromide. Sodium salt of the dimercaptide and ethylene bromide forms diethylenedisulfide.

262 **Meyer, V., and Neure, K. B.A.** 1887, 805. *Ber.* 20, 1756. By-products of the Manufacture of Thiophene. In the high boiling fraction some thi succinic anhydride was isolated. Found also thiethyl mercaptan. Prepared disulfide, methyl ether, acetyl derivative and silver salt.

263 **Michaelis, A. B.A.** 1872, 283. *Ber.* 5, 6. Phosphoric Sulfobromochloride. Prepared $\text{PCl}_2(\text{SET})$ from PCl_3 and EtSH , b. p. 172°-175°: decomposes into mercaptan, etc., with H_2O . $\text{P}(\text{SET})_3$ is prepared in above reaction also, b. p. 240°-280°. Odor unpleasant but not like mercaptan. Prepared PSClBr from PCl_2SET and bromine in H_2O . Gives possible explanation.

264 **Michaelis, A., and Linke, G. L. C.A.** 1908, 84. *Ber.* 40, 3419-25. Thiophenol-s-chlorphosphine and its Derivatives.

In air yields thiophenol phosphine. Water converts it into HCl , H_3PO_3 and thiophenol. Reactions with EtOH , halogens, CH_3I , H_2O_2 and permanganate.

265 **Michaelis, A. C.A.** 1908, 2788. *Ann.* 361, 251-301. Thiopyrazolones. These compounds and their various derivatives are given in a voluminous article.

266 **Michler, W. B.A.** 1875, 761. *Ann.* 176, 177-85. Thioethers. Thiophenol and acetyl chloride give thiophenylacetate. Caustic soda decomposes it to thiophenol and acetic acid. On standing in air phenyl disulfide separates. Potash decomposes ethyl thiocacetate to ethyl mercaptan and acetic acid. Mercaptan prepared by distilling potassium sulfhydrate with calcium ethyl sulfate. If other salts are used considerable sulfide is formed.

267 **Mills, W. H., and Whitworth, J. B. C.A.** 1928, 785. *J. Chem. Soc.* 1927, 2738-53. Condensation of o-Aminophenol with α, β -Unsaturated Acids. The preparation and properties of inorg. compounds are given.

268 **Miolati, A. B.A.** 1893, i, 634. *Gazz. chim. ital.* 23, i, 575-80. Synthesis of Mercaptothiazoles. Prepares mercaptans (mercaptothiazoles) by condensation of halogenated ketones and ammonium dithiocarbamate.

269 **Morley, H. F., and Saint, W. J. J. Chem. Soc. Trans.** 1883, 400-2. Thioxalic Ethers. Prepared from chlorethyloxalate and mercaptan. Hydrolyzed by alkali to form ethyl mercaptan.

270 **Morner, K. A. H. B.A.** 1904, i, 836. *Z. physiol. Chem.* 42, 365-70. Is α -Thiolactic Acid a Direct Decomposition Product of Proteids? Cystine was identified but no α -thiolactic acid or the disulfide. Is it formed as secondary product on hydrolysis?

271 **Morrell, J. C., and Faragher, W. F. C.A.** 1927, 3450. *Ind. Eng. Chem.* 19, 1045-9. Rôle of Lead Sulfide in the Sweetening of Petroleum Distillates and Chemistry of the Mercaptans. Experiments were carried out on Et, Bu, isoamyl and Bz mercaptans in sulfur free naphthas.

272 **Muller, M. B.A.** 1871, 904. *J. prakt. Chem.* [2] 4, 39. On Ethyl Sulfides. EtSH heated in sealed tube for 6 hours at 150° with sulfur forms sulfide and H_2S . Selenium does not act on mercaptan. Ethyl disulfide heated with sulfur forms ethyl trisulfide. Shaking with Hg , third atom of S slowly removed. On oxidation with fuming nitric gives sulfuric and sulfonic acids. Reaction of trisulfide with various reagents given. Third atom of sulfur held loosely.

273 **Mylius, E. B.A.** 1873, 267. *Ber.* 5, 978. Isobutylsulfonic Acid. Oxidized isobutyl mercaptan with nitric acid, sp. gr. 1.30. Can evap. in vac. over sulfuric acid to crystalline mass. Salts very soluble. Silver salt not acted on by light. Barium salt pptd. from concentrated aqueous solution by alcohol.

274 Nencki, M., and Bourquin. B.A. 1885, 40. Ber. 17, 2277-82. Rhodanic Acid.
Considers the formula and its reactions with alkali and water with heat. Other reactions also given.

275 Neuberg, C. B.A. 1902, i, 743. Ber. 35, 3161-4. Cystein, I.
Reports on the oxidation products with nitric acid. Shows sulfhydryl and amino groups are attached to different carbon atoms of cystein molecule.

276 Neuberg, C., and Mayer, P. B.A. 1905, i, 567. Z. physiol. Chem. 44, 472-97. Cystein.
Gives some derivatives of cystein. Also mercury salts.

277 Neuberg, C., and Nord, F. F. C.A. 1914, 3299. Ber. 47, 2264-71. Phytochemical Formation of Ethyl Mercaptan.
An alcoholic solution of thiadine was added to a fermenting mixture of sugar in water. In a short time the odor of C_6H_5SH was perceptible. 1.3 g. pure $(EtS)_2Pb$ was obtained from 20 g. thiadine.

278 Nord, F. F. C.A. 1920, 55. Ber. 52B, 1207-11. Biochemical Formation of Mercaptans.*

279 Obermeyer, J. B.A. 1888, 124. Ber. 20, 2918-28. Methyl Mercaptan and Some of its Derivatives.
Using lead methyl mercaptide prepared methyl thio acids. Methyl alkyl sulfides were mostly prepared by treating alkyl sodium mercaptide with methyl iodide.

280 Otto, R. B.A. 1877, ii, 749. Ber. 10, 939-41. Preparation of Benzene Hydrodisulfide from Benzene Sulfinic Acid. New Method of Converting Benzene Disulfide into Benzene Hydrodisulfide.
Convert benzene sulfonic acid to benzene sulfon chloride to benzene sulfinic acid. Reduce this with zinc and hydrochloric acid to mercaptan. Any disulfide formed is reduced at the same time. See abstract.

281 Otto, R. B.A. 1880, 810. Ber. 13, 1290-2. Action of Sulfuric Acid on Aromatic Sulphydrates.
Confirms the accuracy of Stenhouse's observation (Ann. 149, 247) that thiophenol is converted into phenyl disulfide by the action of sulfuric acid. Another compound is also formed at the same time. Paratoluene and benzyl mercaptans undergo analogous changes when treated with sulfuric acid.

282 Otto, R., and Luders, R. B.A. 1880, 811. Ber. 13, 1283-9. Benzyl Derivatives Containing Sulfur.
Benzyl mercaptan is not converted into the disulfide by the action of bromine. Dibenzylsulfone can be prepared by oxidizing with potassium permanganate a hot acetic acid solution of benzyl oxysulfide obtained by treating benzyl sulfide with cold nitric acid. Benzyl thiobenzoate is prepared from benzyl mercaptan and benzoyl chloride at 120°. Decomposed by alcoholic potash into benzoic acid and benzyl mercaptan. Benzylsulfonic acid fused with alkali gives toluene.

283 Otto, R. B.A. 1880, 812. Ber. 13, 1282-3. Synthesis of Ethereal Salts of Thiosulfonates.
Ethyl thiobenzenesulfonate or ethyl phenyl disulfoxide is formed on warming an alcoholic solution of ethyl bromide and potassium thiobenzenesulfate (prepared by Spring's method (Ber. 7, 1157), i. e., by potassium sulfide on benzenesulfonic chloride). Ester is not attacked by water at 120° but is easily saponified by potash and decomposed by reducing agents.

284 Otto, R., and Rossing, A. B.A. 1886, 692. Ber. 19, 1227-34. Ethyl Phenylthioformate (Ethyl Phenylthiocarbonate).
Prepared by boiling zinc phenyl mercaptide and ethyl chlorocarbonate. Thiophenol and phenyl disulfide are formed in the reaction. When heated with 25% NaOH forms ethyl phenyl sulfide. Same with water at 230°. Reacts with ammonia. Permanganate oxidizes it to sulfonic acid.

285 Otto, R., and Rossing, A. B.A. 1886, 711. Ber. 19, 1235-42. Products of the Hydrolysis of Ethereal Thiosulfonates.
When phenylthiobenzene sulfonate is saponified with potash or baryta it yields phenyl disulfide, a salt of benzene sulfonic acid and a trace of thiophenol. No benzene sulfonic acid is formed.

286 Otto, R., and Rossing, A. B.A. 1887, 226. Ber. 19, 3129-32. Reaction of Organic Disulfides and Disulfoxides with Potassium Sulfide.
Disulfides and potassium sulfides in alcohol form potassium mercaptide and potassium disulfide. The thiosulfonates of formula $RSO_2 \cdot SR$ are decomposed by potassium sulfide to potassium thiosulfonic acid and potassium mercaptides.

287 Otto, R., and Rossing, A. B.A. 1887, 242. Ber. 19, 3132-8. Disulfides with Mixed Organic Radicals.
 $R \cdot SH + R'SH + Br_2 \rightarrow 2HBr + R \cdot S_2 \cdot R'$
Such compounds are formed when a mixture of 2 mercaptans is treated with bromine, and the reactions take place the more readily the more closely allied are the radicals of the reacting mercaptans. See abstract.

288 Otto, R., and Rossing, A. B.A. 1887, 371. Ber. 20, 189-91. Action of Potassium Hydroxide on Mixed Alkyl Disulfides.
Ethyl phenyl disulfide warmed with small quantities of alcoholic potash, the following compounds are obtained: ethyl sulfonic acid, benzenesulfonic acid, ethyl mercaptan, phenyl disulfide from oxidation of phenyl mercaptide.

289 Otto, R., and Rossing, A. B.A. 1887, 953. Ber. 20, 2079-88. Aromatic Thiosulfonates Containing Bivalent Alkyl Radicals.
Prepared ethylene thiobenzenesulfonate. This on hydrolysis with alcoholic KOH at 100° gave benzene sulfonic acid, ethylene disulfinic acid, ethylene mercaptan and ethylene disulfide. Prepared other derivatives having ethylene group.

290 Otto, R., and Rossing, A. B.A. 1887, 954. Ber. 20, 2090-2. Reduction of Aromatic Thiosulfonates Containing

Univalent and Bivalent Alkyl Radicals with Hydrogen Sulfides.

Reduce phenyl thiobenzene sulfonate with hydrogen sulfide in dilute alcoholic solution, thiophenol and sodium benzenesulfonate are obtained as well as a polysulfide. See abstract.

291 Otto, R., and Rossing, A. B.A. 1887, 1047. Ber. 20, 2275-8. Behavior of Aromatic Sulfonic Ethers Toward Hydrogen Sulfide.

Ethyl mercaptan and benzene sulfonic acid are formed from ethyl benzene sulfinate. Sulfonic acid is further decomposed into benzene disulfoxide and benzene sulfonic acid. Phenyl ethyl sulfide is also formed. See abstract.

292 Otto, R. B.A. 1888, 482. Ber. 21, 652-8. Formation of Monosulfones.

Reports decomposition of methylene-iodophenylsulfone and sodium benzenesulfinate in alkaline solution in sealed tubes at 200°. Gives a number of products as methylphenyl sulfone, phenyl mercaptan, benzene sulfonic acid, etc. From given and unpublished data states: dihalogen derivatives of hydrocarbons, fatty acids and their ethereal salts in which the halogen atoms are united to the same carbon atom, when treated with alkaline sulfonates only exchange a single atom for the group $R'SO_2$; the second halogen atom in the presence of water being displaced by hydrogen.

293 Otto, R., and Rossing, A. B.A. 1891, 568. Ber. 24, 234-7. Phenylsulfone-acetone Mercaptone.

On oxidation forms disulfone. Further oxidation forms sulfonic acid. Aqueous potash converts it into methyl phenyl sulfone, thiophenol, and acetic acid. Not attacked by reducing reagents.

294 Otto, R. B.A. 1891, 720. Ber. 713-6. Behavior of Sulfonic Chlorides Towards Thiophenols and Thioalcohols in the Presence of Alkalies.

Benzene sulfonic chloride and thiophenol yield benzene sulfonic acid and phenyl disulfide.

295 Otto, R., and Troger, J. B.A. 1891, 924. Ber. 24, 1145-6. Action of Iodine on Sodium Benzenesulfinate in the Presence of Mercaptan.

Attempted to get disulfoxides by the action of iodine on a mixture of mercaptan and an alkaline sulfinate but no success. Yielded phenyl disulfide and benzenesulfide.

296 Otto, R., and Heydecke, E. B.A. 1892, 990. Ber. 25, 1477-83. Aromatic Thiolsulfonates.

Prepared ethylene paratoluene thiosulfonate and studied its decomposition. With alkali forms ethylene disulfinate, potassium toluene sulfinate and diethylene tetrasulfide. See abstract for other decompositions.

297 Pasca, E. C.A. 1925, 2056. Ber. 58B, 509-13. Degradation of the Mercaptals of the Monosaccharides and a New Synthesis of the Alcohol Glucosides.

See article.

298 Patten, A. J. B.A. 1903, i, 792. Z. physiol. Chem. 39, 350-5. Cystine. Considers cystine and cysteine from physiological importance.

299 Pauly, C. B.A. 1877, ii, 734. Ber. 10, 941-3. Formation of Sulfonic Acids of the Fatty Group from the Chloroanhydrides of the Sulfonic Acids.

Prepared from alkyl sulfochloride and zinc dust. Prepared ethyl and isobutyl acids. Gives method of preparing sulfochloride from mercaptan.

300 Pinner, A., and Klein, F. B.A. 1878, 865. Ber. 11, i, 762-4. Azobenzene Sulfonic Acids.

On dry distillation of barium azobenzene sulfonate, azophenylene, and azobenzene sulfhydrate are formed. Crystalline derivative of sulfhydrate formed with mercuric chloride which is soluble in alcohol.

301 Pinner, A., and Klein, F. B.A. 1879, 147. Ber. 11, 1825. Imidothioethers.

Hydrochloride of an imidothioether is formed when HCl is passed into a mixture of a nitrile and a mercaptan. Free imidoether obtained by adding caustic soda.

302 Pishchimuka, P. S. C.A. 1925, 2808. J. Russ. Phys. Chem. Soc. 56, 11-4. Action of Phosphorus Pentasulfide on Alcohols.

Author finds EtSH not a product of reaction between P_2S_5 and EtOH, but results from decomposition of the $SP(OEt)_2SH$ at high temperatures.

303 Pollak, J., and Carniol, J. C.A. 1909, 2955. Ber. 42, 3252-3. Trithiophloroglucinol.

Prepared by reduction of corresponding trisulfonic chloride of benzene. Quickly oxidized in alkaline solution to polymeric sulfide. Triacetyl and trimethyl ether given.

304 Pollak, J., and Tucakovic, R. C.A. 1911, 1754. Monatsh. 31, 695-707. Symmetrical Trithiophenols.

Methyltrithiophloroglucinol and various derivatives are given. Compound prepared by action of Sn and HCl on toluene trisulfone chloride.

305 Pollak, J. C.A. 1915, 910. Monatsh. 35, 1445-65. Polyhydric Mercaptans of the Benzene Series, IV.

The sulfonation of thiophenol, thioanisole and dithioresorcinal dimethyl ether is studied.

306 Pollak, J., and Wienerberger, A. C.A. 1915, 911. Monatsh. 35, 1467-91. V. Substituted Metadimercapto-benzenes.*

307 Pollak, J., and Schadler, B. C.A. 1919, 418. Monatsh. 39, 129-48. Polyhydric Mercaptans of the Benzene Series. VI, Homologous Dithiolbenzenes.

Obtained by reduction of corresponding disulfonyl chlorides. The thioethers in some cases were made. Their reaction with halogens and $KMnO_4$ given in certain cases.

308 **Pollak, J., and Schadler, B.** *C.A.* 1919, 419. *Monatsh.* 39, 179-200. VII, Substituted Thiobenzenes. Various substitutions are made and their properties given.

309 **Pollak, J., and Riesz, E.** *C.A.* 1929, 825. *Monatsh.* 50, 251-62. Hydroxythiophenols. The preparation and properties of various compounds given.

310 **Posner, T.** *B.A.* 1900, i, 5. *Ber.* 32, 2801-15. Disulfones. III, Mercaptoles and Disulfones of Ketonic Acids and Unsaturated Acids Derived Therefrom. Mostly butyric acid derivatives. See abstract.

311 **Posner, T.** *B.A.* 1901, i, 14. *Ber.* 33, 2983-93. Disulfones. IV, Mercaptoles and Sulfones from Diketones. Diketones which contain both carbonyl groups attached to methyl radicals (*i.e.*, diacetyl, etc.) readily react with 4 mol. of mercaptan, yielding dimercaptoles and these on oxidation yield tetrasulfones. See abstract for cases where this does not occur.

312 **Posner, T.** *B.A.* 1901, i, 474. *Ber.* 34, 1395-1405. Disulfones. VI, Sulfonal Derivatives of Unsaturated Ketones. Forms mercaptole and then oxidizes to disulfone with permanganate. List of mercaptoles given.

313 **Posner, T.** *B.A.* 1901, i, 703. *Ber.* 34, 2643-73. Disulfones. VII, Mercaptoles and Disulfones of the Ketonic Acids and the Sulfur Acids Obtained From Them. The nature and stability of the mercaptoles and disulfones formed from ketonic esters and the mercaptans are influenced by the nature of the mercaptan and by that of the ketonic ester. Derivatives of the substituted esters are both less easily produced and less stable. Characteristic differences also show themselves in the behavior on hydrolysis. See abstract.

314 **Posner, T.** *B.A.* 1902, i, 220. *Ber.* 35, 493-505. Disulfones. VIII, Mercaptoles and Sulfones from Diketones. Continuation of previous work.

315 **Posner, T.** *B.A.* 1902, i, 220. *Ber.* 35, 506-10. Derivatives of Benzoin Containing Sulfur. Condense benzoin and ethyl mercaptan to form diethyl stilbene. Other mercaptans react likewise.

316 **Posner, T.** *B.A.* 1902, i, 296. *Ber.* 35, 799-816. Disulfones. IX, Derivatives of Unsaturated Ketones Containing Sulfur. Continuation of previous work.

317 **Posner, T.** *B.A.* 1902, i, 622. *Ber.* 35, 2343-54. Disulfones. XI, Influence of Intranucleal Substituents of the Reactivity of Aromatic Aldehydes and Ketones. Continuation of former work. Benzo-phenone and acetophenone interact only with the more reactive mercaptans, but do not condense with amyl or phenyl mercaptan.

318 **Posner, T.** *B.A.* 1903, i, 242. *Ber.* 36, 296-304. Disulfones. XII, Mixed Disulfones. Continuation of previous work. Aldehyde or ketone first adds one mercaptan to form $\text{RCH}(\text{OH})(\text{SR})$ and then in acid solution adds second molecule.

319 **Posner, T.** *B.A.* 1904, i, 322. *Ber.* 37, 502-10. Disulfones. XIII, Sulfur Derivatives of Unsaturated Ketones. Studied influence of double linkage on the formation of sulfones. Discussed in light of Thiele's theory of partial valencies. For sulfones prepared, see abstract.

320 **Posner, T.** *B.A.* 1904, i, 1029. *Ann.* 336, 85-167. Phenoquinone, Thiophenoquinone, and Quinhydrone. Thiophenoquinone (Troeger and Eggert, *B.A.* 1896, i, 562) is formed by the action of thiophenol on the conjugated system of quinone. See abstract for details.

321 **Posner, T.** *B.A.* 1905, i, 279. *Ber.* 38, 646-57. Unsaturated Compounds. II, Addition of Mercaptans to Unsaturated Hydrocarbons. There is a difference between mercaptans in reaction with trimethylethylene. See abstract.

322 **Pratt, L. S., and Reid, E. E.** *C.A.* 1909, 2532. *J. Am. Chem. Soc.* 37, 1934-48. Esterification. VI, Esterification of Benzoic Acid by Mercaptans. Me, Et, Pr, iso-Bu, iso-Am esters studied. Details of reaction given.

323 **Prescott, W. G., and Smiles, S.** *C.A.* 1911, 3047. *J. Chem. Soc.* 99, 640-9. Interaction of Aromatic Disulfides and Sulfuric Acid. Hypothesis explains and correlates all reactions of disulfides and mercaptans in sulfuric acid.

324 **Price, T. S., and Twiss, D. F.** *C.A.* 1910, 750. *J. Chem. Soc.* 95, 1725-9. Preparation of Disulfides. VII, Nitrobenzyl Mercaptans and Disulfides. The action of $(\text{NH}_4)_2\text{S}$ on p-nitrobenzyl chloride give the disulfide, sulfide, and mercaptan. Mercaptan also prepared by treating the chloride in alcohol solution with $\text{Na}_2\text{S}_2\text{O}_3$ dissolving the product in water, adding concentrated sulfuric acid and heating 8 hours. o-, m-, and p-Nitrobenzyl mercaptans given.

325 **Price, T. S., and Twiss, D. F.** *C.A.* 1911, 1076. *J. Chem. Soc.* 97, 1175-83. Action of Sodium or Potassium Hydroxide on Sodium Alkyl Thiosulfates and on Disulfides. Primary result of action of alkali on benzyl disulfide is formation of benzyl mercaptan and BzOH .

326 **Price, W. B., and Smiles, S.** *C.A.* 1929, 135. *J. Chem. Soc.* 1928, 2372-4. Naphthylene 1,8-Disulfide.* Formed by action of water on phenylthioglycolic acid dibromide. α -Chloro-

phenylthioglycollic acid and also α -brom acid given by treatment with corresponding halogen acids. H_2O_2 in AcOH also gives the sulfoxycetic acid.

328 Purgotti, A. B. A. 1893, i, 330. *Gazz. chim. ital.* **22**, ii, 614-20. Action of Sodium Sulfide on Orthodiazophenol Chloride.
Compare Tassinari (B. A. 1892, 1316). Slowly add orthodiazophenol chloride to sodium sulfide solution and on careful purification yields orthooxytrithiobenzene. On reduction gives mercaptan. Salts discussed.

329 Rabaut, C. B. A. 1902, i, 673. *Bull. soc. chim.* [3] **27**, 690-2. Some Derivatives of the Thiocresols.
p-Tolylthiocyanate prepared by Sandmeyer reaction. When treated with aqueous or alcoholic solution of KOH forms p-tolyl disulfide. Reduce to p-thiocresol. Forms lead salt which with bromine gives disulfide, with acetyl chloride forms p-tolyl thioacetate. Formed p-tolyl thioglycollic acid. α -Tolyl derivatives prepared also.

330 Radziwillowicz. B. A. 1889, 430. *Berlin klin. Wochschr.* **25**, 835-6. *Chem. Zentr.* **1888**, 1415. Cystine.
Gives tests using potassium mercuric iodide, iodine in KI or phosphotungstic acid.

331 Raffo, M., and Rossi, G. C. A. 1915, 1473. *Gazz. chim. ital.* **45**, 28-34. Action of Pyridine on Some Sulfurated and Selenated Organic Compounds.
Reactions with PhSH, PhCSNH₂, and allylthiourea were studied. Mercaptans react to form disulfides.

332 Ramberg, L. B. A. 1906, i, 396. *Ber.* **39**, 1356-8. Antimony Derivatives of Thioglycollic Acid.
Moderately strong acid. Other salts are described.

333 Rathke, B. B. A. 1871, 344. *Z. f. Chem.* [2] **7**, 50. On Sulfocarbonyl Chloride and a New Sulfochloride of Carbon or Perchloromethyl Mercaptan.
Perchloromethyl mercaptan ($CCl_4 \cdot SCI$) — methods of preparation and properties. See abstract or original.

334 Rathke, B. B. A. 1886, 458. *Ber.* **19**, 395-6. Compounds of Perchloromethyl Mercaptan with Aromatic Amines.
Reaction with aniline and paratoluidine.

335 Ray, P. C. C. A. 1916, 1325. *J. Chem. Soc.* **109**, 131-8. Nitromercaptides and their Reaction with the Alkyl Iodides. Compounds of the Disulfonium Series.
A study of the action of $Hg(NO_2)_2$ on mercaptans and of the action of alkyl iodides on the compounds formed.

336 Ray, P. C., and Guha, P. C. C. A. 1919, 1707. *J. Chem. Soc.* **115**, 261-71. Mercury Mercaptide Nitrites and their Reaction with the Alkyl Iodides. IV, Chain Compounds of Sulfur.
Studies were made of reaction between $Hg(NO_2)_2$ and various mercaptans and between $Hg(NO_2)_2$ and certain sulfur ethers, also between alkyl halides and resulting products of above two reactions.

337 Ray, P. C., and Guha, P. C. C. A. 1919, 2021. *J. Chem. Soc.* **115**, 541-8. Mercury Mercaptide Nitrites and their Reaction with the Alkyl Iodides. V, Chain Compounds of Sulfur.
Investigations extended to di-mercaptans. See abstract for details of reaction.

338 Ray, P. C. C. A. 1919, 2858. *J. Chem. Soc.* **115**, 871-8. Interaction of Mercuric and Cupric Chlorides Respectively and the Mercaptans and Potential Mercaptans.
 $HgCl_2$ reacts with RSH to form $R \cdot S \cdot HgCl_2$. $CuCl_2$ and $PtCl_4$ generally give mercaptides alone or mercaptides with only slight admixture of chloromercaptides.

339 Ray, P. C., and Guha, P. C. C. A. 1920, 736. *J. Chem. Soc.* **115**, 1148-55. Mercury Mercaptide Nitrites and their Reaction with the Alkyl Halides. VII, Chain Compounds of Sulfur.*

340 Ray, P. C., and Das, R. C. A. 1922, 1953. *J. Chem. Soc.* **121**, 323-8. Chloropicrin as a Reagent for the Diagnosis of Mercaptans and Potential Mercaptans.
In all cases of real mercaptans examined there is no separation of sulfur upon treatment with CCl_4NO_2 , whereas sulfur is either partly or completely eliminated from the potential ones.

341 Ray, P. C. C. A. 1923, 1470. *J. Chem. Soc.* **123**, 133-41. Varying Valency of Platinum with Respect to Mercaptanic Radicals.
At lab. temperatures hexavalent Pt compounds are usually obtained. By varying the concentrations of solutions quinquevalent compounds have been obtained at this same temperature. If temperature be reduced 5°-15°, only octavalent compounds will be produced.

342 Ray, P. C., Chakravarti, G. C., and Bose, P. K. C. A. 1923, 3484. *J. Chem. Soc.* **123** 1957-62. Mercaptans of the Purine Group.
Various derivatives of the purines given.

343 Ray, P. C. C. A. 1924, 2332. *J. Chem. Soc.* **125**, 1141-4. Synthesis of Cyclic Polysulfides. I, Condensation of Dithioethylene Glycol with Benzylidene Chloride.
The preparation and properties of the above products given.

344 Ray, P. C. C. A. 1925, 815. *Quart. J. Indian Chem. Soc.* **1**, 63-73. Varying Valency of Gold with Respect to Mercaptanic Radicals.*

345 Ray, P. C., and Bose-Ray, K. C. C. A. 1926, 3687. *Quart. J. Indian Chem. Soc.* **3**, 75-80. Lengthened Chain Compounds of Sulfur.
1, 4-Dithian can be prepared from $C_2H_4(SH)_2$ and $C_2H_4Br_2$ in presence of NaOEt if $C_2H_4Br_2$ is gradually added with cooling. In more concentrated solutions with excess $C_2H_4Br_2$ polymers are formed.

346 Ray, P. C., Guha, B. C., and Bose-Ray, K. C. C. A. 1927, 2855. *Quart.*

J. Indian Chem. Soc. **3**, 358-70. Varying Valency of Platinum with Respect to Mercaptan Radicals. IV, The Inadequacy of Werner's Theory to Explain Certain Anomalous Cases.*

347 Ray, P. C., Bose-Ray, K. C., and Adhikari, N. B. *C. A.* 1928, 1922. *Quart. J. Indian Chem. Soc.* **4**, 467-75. Varying Valency of Platinum with Respect to Mercaptanic Radicals.*

348 Ray, P. C., and Bose-Ray, K. C. *C. A.* 1929, 1586. *J. Indian Chem. Soc.* **5**, 527-33. Complex Compounds of Gold with Mercaptanic Radicals. II, Residual Affinities of Chloroauric Acid.*

349 Recsei, A. *C. A.* 1927, 2884. *Ber. 60B*, 1420-3. Aliphatic and Aicyclic Disulfones. EtSH condensed with certain ketones to form mercaptols which were then oxidized to disulfones with KMnO₄.

350 Reid, E. E. *C. A.* 1910, 2270. *Am. Chem. J.* **43**, 489-504. Studies in Esterification: Esterification of Thiolbenzoic Acid by Alcohol and of Benzoic Acid by Mercaptan. Author finds that the esterification of thiolbenzoic acid by alcohol and BzOH by EtSH is in accordance with Henry's hypothesis.

351 Reid, E. E., Mackall, C. M., and Miller, G. E. *C. A.* 1922, 256. *J. Am. Chem. Soc.* **43**, 2104-17. Derivatives of Anthraquinone. Aliphatic Thioethers and Thioether Sulfonic Acids.*

352 Reissert, A., and Manns, E. *C. A.* 1928, 4114. *Ber. 61B*, 1308-16. Amides of Thio- and Dithio-salicylic Acid.*

353 Rheinboldt, H. *C. A.* 1926, 2975. *Ber. 59B*, 1311-3. Nitrosyl Mercaptides and Thionitrites (Preliminary Communication). All primary and secondary mercaptans and their salts react with NOCl as described by Tasker and Jones (*C. A.* 1910, 1023). These are wine red solutions stable at room temperatures but evolving NO and yielding corresponding disulfide at room temperature. Tertiary-mercaptans act differently.

354 Rheinboldt, H. *C. A.* 1927, 1626. *Ber. 60B*, 184-6. A Simple Reaction for Sulfhydryl Groups. A test for mercaptans, simpler and just as sensitive as that of Lecher and Sieffken, is with nascent HNO₂. It brings out clearly the difference between primary and secondary aliphatic mercaptans on one hand and tertiary and aromatic mercaptans on the other. The former give only a red, while the latter give a green solution which then turns red. Thiol acids act like tertiary mercaptans. Limit of sensitivity given.

355 Riesz, E., and Frankfurter, W. *C. A.* 1928, 3644. *Monatsh.* **50**, 68-75. Sulfur Containing Derivatives of Acetophenone. Certain mercapto derivatives are given.

356 Roderburg, F. *B. A.* 1873, 1030. *Ber. 6*, 669-70. Oxyccymene and Thioccymene. Thioccymene formed by reduction of cyrene sulfonic acid.

357 Roos, J. *B. A.* 1888, 500. *Ber. 21*, 619-30. Thio-derivatives of Quinoline. α -Quinolyl mercaptan, disulfide, ethyl sulfide, γ -methyl quinolyl mercaptan, ethyl sulfide were prepared. See abstract or original.

358 Rosenheim, A., and Stadler, W. *B. A.* 1905, i, 740. *Ber. 38*, 2687-90. Formation of Complex Salts with Thio-acids. II, Thiomalic Acids and their Salts.*

359 Rosenheim, A., and Davidsohn, I. *B. A.* 1904, i, 843. *Z. anorg. Chem.* **41**, 231-48. Formation of Complex Salts of Thio-acids. Thioglycollates. Formation of many salts—both on the carboxyl group and the mercaptan. See abstract.

360 Rudloff, J. *B. A.* 1878, 414. *Ber. 11*, 32. Derivatives of Pseudocumensulfonic Acid. Prepared sulfonchloride, sulfinic acid, mercaptan and disulfide.

361 Ruff, O. *B. A.* 1902, i, 590. *Ber. 35*, 2360-70. The Degradation of Rhammonic and Iso-saccharic Acids. Methyltetrose forms ethyl mercaptal.

362 Ruhemann, S. *J. Chem. Soc. Trans.* 1905, 17-25. The Combination of Mercaptans with Olefinic Ketonic Compounds. Condensed mercaptans to unsaturated group of a ketone leaving carbonyl group untouched. Used thiophenol.

363 Ruhemann, S. *J. Chem. Soc. Trans.* 1905, 461-468. The Combination of Mercaptans with Unsaturated Ketonic Compounds. Condensed mercaptans with unsaturated ketones. Did not condense on carbonyl group.

364 Sabatier, P., and Mailhe, A. *C. A.* 1910, 2935. *Compt. rend.* **150**, 1569-72. Formation and Decomposition of Thiols. Synthesis of Alkyl Sulfides. Authors claim ThO₂ is only metallic oxide that gives good results for making thiols. On heating thiols moderately with CdS sulfides are formed, while at higher temperatures hydrocarbons are formed.

365 Sachs, J. J., and Reid, E. E. *C. A.* 1917, 337. *J. Am. Chem. Soc.* **38**, 2746-57. Esterification. VII, Esterification of o-, m-, and p-Toluidic Acids by Ethyl Mercaptan. Authors show RSH esterifies just as alcohols. Limits of esterification of EtSH much lower than EtOH. Limit in acid-mercaptan series is independent of proportions of reacting substances.

366 Sachs, G. *C. A.* 1921, 848. *Ber. 53B*, 1737-45. Action of Mercaptans and Hydrogen Sulfide on o-Chloromercurybenzoyl Chloride.*

367 **Sachs, G. C. A.** 1922, 905. *Ber.* 54B, 1849-54. Decomposition of Thiolacetic Ester by Mercury Salts. A Contribution to the Chemistry of Mercaptides of Mercury.
AcSET treated with $Hg(OAc)_2$ in alcohol containing a little water and $AcOH$, then diluted with equal volume of water and precipitated with 20% $NaCl$ yields 80-100% of $EtSHgCl$.

368 **Sachs, G. C. A.** 1924, 3154. *Z. anorg. allgem. Chem.* 135, 273-82. The Ethyl Mercapto-mercury Salts.
These salts have the general formula C_2H_5SHgX . Sachs describes the preparation and properties of various ones.

369 **Sammis, J. L. B. A.** 1905, i, 797. *J. Am. Chem. Soc.* 27, 1120-27. Action of Mercaptides on Quinones.
Gives improved method of preparing tetraethylthioloquinone. Derivatives prepared.

370 **Schiller, R., and Otto, R. B. A.** 1877, i, 306. *Ber.* 9, 1587-8. Preparation of Benzene and Paratoluene Sulphydrates.
Readily obtained by adding zinc or sodium salts of the corresponding sulfinic acids in small quantities to a mixture of zinc and hydrochloric acid (kept cold).

371 **Schiller, R., and Otto, R. B. A.** 1877, i, 306. *Ber.* 9, 1588-91. Formation of Benzene and Paratoluene Disulfide.
Reduction of sulfonic and sulfinic acids by hydrogen, mercaptan and disulfide are formed; more disulfide if not kept cold.

372 **Schiller, R., and Otto, R. B. A.** 1877, i, 463. *Ber.* 9, 1638. Action of Sulfur Trioxide on Sulphydrates.
Phenyl mercaptan and sulfur trioxide give disulfide and sulfur dioxide.

373 **Schiller, R., and Otto, R. B. A.** 1877, i, 468. *Ber.* 9, 1634-6. Phenyl-thiobenzoate and Paratolylthiobenzoate.
Benzoyl chloride and phenyl mercaptan give the thiobenzoate. With chlorine in water yields benzoic acid and sulfonic acid. Tolyl compound is analogous.

374 **Schlagdenhauffen, F. B. A.** 1873, 868. *Compt. rend.* 126, 1021-3. Action of Sodium Sulfide upon Glycerine.
Crystallized sodium sulfide was heated with half its weight of glycerine for 20 hours. Distill until dry. Odor resembling mercaptan—may be ethyl mercaptan. Potassium sulfocyanate appears to act upon glycerine analogously.

375 **Schmidt, A. C. A.** 1925, 265. *Bull. soc. chim. România* 6, 34-6. Ethyl Mercaptole of Phenyl Ethyl Ketone.
Prepared by agitating 1 part of ketone with 2 parts of mercaptan with a little anhyd. $ZnCl_2$ and introducing HCl gas. Disulfone given.

376 **Schmitt, R., and Mittenzwey, O. B. A.** 1879, 304. *J. prakt. Chem.* [2] 18, 192-5. Action of Diazo Compounds on Ethyl Mercaptan.
In sealed tube forms disulfide and phenol from mercaptan.

377 **Schneider, W., and Stiehler, O. C. A.** 1920, 2178. *Ber.* 52B, 2131-5. Action of Hydrogen Sulfide on Sugars.
A product resembling $C_6H_{11}O_6SH$ was obtained by passing H_2S into glucose dissolved in pyridine.

378 **Schneider, W., and Beuther, A. C. A.** 1920, 2178. *Ber.* 52B, 2135-49. Sulfur-containing Disaccharides from Galactose.*

379 **Schonberg, A., and Schutz, O. C. A.** 1927, 2674. *Ann.* 454, 47-53. Organic Sulfur Compounds. VI, Relation Between Constitution and Heat Stability of Organic Compounds. Thermal Decompositon of Mercaptols.*

380 **Schonberg, A., Schutz, O., Arend, G., and Peter, J. C. A.** 1928, 587. *Ber.* 60B, 2344-51. Organic Sulfur Compounds. VII, Behavior of Mercaptols Towards Phenanthrenequinone, Isatin and α, β -Unsaturated Ketones.
Ph. benzyl, Et and Bu mercaptans and $HSCH_2COOH$ react with phenanthrenequinone to give well cryst. products. Other reagents also discussed.

381 **Schonberg, A., Schutz, O., and Nickel, S. C. A.** 1929, 379. *Ber.* 61B, 2175-7. Organic Sulfur Compounds. X, Remarks on the Action of Air on Thiobenzophenone.*

382 **Schone, H. B. A.** 1885, 512. *J. prakt. Chem.* [2] 30, 416. Chlorocarbonylsulfamyl.
Prepared by the action of carbonyl-chloride on amyl mercaptan. Forms amide, anilide and carbamide.

383 **Schone, H. B. A.** 1886, 337. *J. prakt. Chem.* [2] 32, 241-61. Amyl Trithiocarbonylchlorocarbonate and its Action on Compounds Containing Nitrogen.
Amyl thiocarbonylchlorocarbonate was prepared from amyl mercaptan and carbonyl chloride. It reacts with ammonia and various amines.

384 **Schwalbe, C. B. A.** 1906, i, 841. *Ber.* 39, 3102-5. Reduction of Aromatic Sulfo-acids to Mercaptans by Alkali Hydrosulfides.
Sodium naphthalene β -sulfonate and 50% solution of KSH are heated for 3 hours at $200^{\circ}-220^{\circ}$ under a pressure of 10-12 atm. in an iron vessel. Yield mercaptan and disulfides.

385 **Sherlin, S. M., and Vasilevskii, V. V. C. A.** 1929, 2417. *J. Russ. Phys. Chem. Soc. (Chem. Part)* 60, 1629-32. Allyl β -Hydroxyethyl Sulfide and Derivatives.
Its preparation and properties given.

386 **Smiles, S., and Harrison, D. C. C. A.** 1923, 85. *J. Chem. Soc.* 121, 2022-6. p-Dithiobenzoic Acid.
Reduction of p-chlorosulfonyl benzoic acid yields p-sulfobenzoic acid. With Zn and $AcOH$ former yields p-thiobenzoic acid. It was characterized by conversion into Me derivative of dithiobenzoic acid.

387 **Smith, W. J. B.A. 1893, ii, 288.** *Z. physiol. Chem.* **17**, 459-67. The Influence of Certain Sulfur Compounds on Metabolism.
Acetone ethyl mercaptol, α -trithioaldehyde, thioglycolic acid, ethyldene diethylsulphone, ethylene diethylsulfone were fed to a dog. The urine was collected, analyzed and compared with blank collections. Results given in abstract.

388 **Smith, W. J. B.A. 1895, ii, 24.** *Pflüger's Archiv.* **57**, 418-26. Formation of Sulfuric Acid in the Organism.
Mercaptans like thioacids are decomposed in the organism and lead to increased sulfates in urine. Ethyl mercaptan is decomposed in body while not so easy outside body to break carbon sulfur linkage.

389 **Smythe, J. A. C.A. 1914, 2367.** *J. Chem. Soc.* **105**, 546-58. Oxidation of Some Benzyl Compounds of Sulfur. II, Benzyl Tetrasulfide.
(PhCH_2S)₂S with H_2O_2 gave sulfuric acid, $\text{PhCH}_2\text{SO}_3\text{H}$, disulfoxide, and benzyl tetrasulfoxide.

390 **Smythe, J. A. C.A. 1909, 2119.** *J. Chem. Soc.* **95**, 349-70. Benzyl Sulfoxide: A Possible Example of Dynamic Isomerism.
Dry HCl reacts with benzyl sulfoxide to form benzyl sulfide, disulfide, disulfoxide, and benzaldehydebenzylmercaptal. This reaction with various solvents studied.

391 **Smythe, J. A. C.A. 1913, 2192.** *Proc. Univ. Durham Phil. Soc.* **4**, 220-2. Preparation of Benzyl Mercaptan.
(PhCH_2S)₂ is reduced with Fe filings in glacial AcOH solution. Mixtures of the sulfide and disulfide may also be treated the same way.

392 **Smythe J. A. C.A. 1922, 3078.** *J. Chem. Soc.* **121**, 1400-5. Decomposition of Benzyl Disulfide.
Heated at 150° in CO_2 gave 15.3% SO_2 (theory 23%). Other reaction products are (PhCH_2S)₂S, (PhCH_2S_2), BzH , PHCH_2OAc , and $\text{PhCH}_2\text{COSMe}$.

393 **Spahr, A. B.A. 1903, i, 477.** *Arch. Sci. phys. nat.* 1903 [4] **15**, 336-7. Aryl Thiocyanates and their Action on Thioacetic Acid and Ethyl Mercaptan.
Aryl thiocyanates best prepared from lead mercaptides and cyanogen chloride. Method good and product better than that obtained by method of Anschutz (B.A. 1889, 707). Phenyl thiocyanate combines with thioacetic acid to form acetylthiomidothiocarbonate. Decomposition of this compound studied.

394 **Spring, W. B.A. 1875 129.** *Ber.* **7**, 1157-63. Polythionic Acids.
Benzenesulfonic chloride acts on potassium sulfide with the production of a salt of benzene hyposulfurous acid. Discusses production of tri- and di-thionates. Mercaptan and sodium sulfite treated with iodine give acid ether of thiosulfuric acid.

395 **Spring, W. B.A. 1884, 580.** *Bull. soc. chim.* [2] **40**, 66-71. Duplothi-acetone.
Acetone and phosphorus pentasulfide form $2\text{C}_2\text{H}_6\text{S}$. By sodium amalgam trans-

formed into isopropyl mercaptan and $\text{C}_2\text{H}_{12}\text{S}$, a sulfur analog to mesityl oxide. On oxidation yields methyl and isopropyl sulfonic acids. See abstract for reactions with chlorine and historical references.

396 **Spring, W., and Van Marsenille, J. B.A. 1892, 1317.** *Bull. soc. chim.* [3] **7**, 13-16. Thiopinacone.
Prepared from cinnamene dibromide by heating in sealed tubes with alcoholic KSH at 120°-130° for 30 hours. It is unstable product and loses H_2S to form $\text{C}_8\text{H}_8\text{S}$.

397 **Stadler, O. B.A. 1884, 1328.** *Ber.* **17**, 2075-81. Mercaptans.
Analogy of behavior of mercaptans and phenols. Diazobenzene sulfonic acid on ethyl mercaptan and soda in ice water gives an unstable yellow crystalline compound. It explodes on heating on platinum foil. Warming in alcohol gives $\text{SO}_3\text{NaC}_6\text{H}_4\text{SEt}$. Distilled with ammonium chloride yields ethylphenylsulfide. EtSH and diazonium salt does not go as smoothly. Phenyl mercaptan is conveniently prepared by distilling a mixture of sodium benzenesulfonate and potassium hydrosulfide in vacuum.

398 **Stadler, O. B.A. 1885, 1204.** *Ber.* **18**, 2316-20. Compounds of Thiophene.
Prepared amidothiophenehydrochloride, nitrothienol, and a compound with diazo-benzene chloride and thiophene hydrochloride. Thiophene hydrochloride and methyl alcohol heated in sealed tubes at 250°-280° gave methyl mercaptan and carbonaceous products.

399 **Stadnikov, G. L., Gavrilov, N. M., and Rakovskii, V. E. C.A. 1926, 1706.** *J. Chem. Ind. (Moscow)* **2**, 315-9. Elimination of Sulfur Impurities from Technical Cresols and Petroleum.*

400 **Stadnikov, G., Gavrilov, N., and Rakovskii, V. C.A. 1926, 2740.** *Brennstoff-Chem.* **7**, 65-8. Desulfurization of Cresols and Acid Fractions of Various Coal Tars.*

401 **Staudinger, H., and Freudenberg, H. C.A. 1928, 4510.** *Ber.* **61B**, 1576-83. Thiobenzophenone.
Preparation and properties described.

402 **Strakosch, J. B.A. 1872, 1027.** *Ber.* **5**, 692-9. Derivatives of Benzylamine.
Nitrobenzyl chloride and alcoholic ammonium sulfide give mercaptan of nitrobenzyl, m. p. 140°. By continued action of ammonium sulfide forms disulfide, m. p. 84°. Same mercaptan is formed by KSH.

403 **Stuffer, E. B.A. 1891, 180.** *Ber.* **23**, 3226-41. Hydrolysis of Sulfones.
Compare B.A. 1890, 987. Prepared sulfide. Oxidized to sulfone and decomposed with alkali. Products produced were identified. See abstract for types of sulfones studied.

404 **Stuffer, E. B.A. 1891, 186.** *Ber.* **23**, 3241-5. Condensation Products of Glyoxal and Some Mercaptans.
Glyoxal combines with EtSH in presence of HCl but the product cannot be obtained in a pure condition. Tetrathio-phenylglyoxal is formed when glyoxal sodium hydrogen sulfite is warmed with

phenyl mercaptan in alcoholic HCl solution. No sulfone could be prepared due to decomposition.

405 **Szahmary, L. v. C. A. 1910, 3232.** *Ber.* **43**, 2485-7. Hydroxythioresorcinol. Gives preparation. Lead salt prepared.

406 **Tarbouriech. B. A. 1901, i, 329.** *Bull. soc. chim.* [3] **25**, 313-5. Action of Mercaptans on Quinones. Ethyl mercaptan is reduced to thialdehyde by quinone.

407 **Taboury, T. B. A. 1907, i, 837.** *Bull. soc. chim.* [4] **1**, 741-2. Action of Bromine in Presence of Aluminum Bromide on Thiophenol and on Phenyl Disulfide. See Bodroux (B. A. 1898, i, 641). Reaction forms from either substance at 0°, s-hexabromophenyl disulfide (m. p. 178°-180°).

408 **Taboury, F. C. A. 1908, 3330.** *Ann. chim. phys.* **15**, 5-66. Contribution to the Study of Sulfur and Selenium Compounds of the Aromatic Series. S crystallized from CS₂ reacted readily with organo-magnesium halides in Et₂O giving RSH. As by-products sulfides and disulfides were obtained. These compounds of toluene, xylene and naphthalene and substituted compound given. Se reacts similarly and the corresponding Se compounds are given.

409 **Thomas, J. S., and Riding, W. R. C. A. 1925, 967.** *J. Chem. Soc.* **125**, 2460-8. Organic Polysulfides. III, The Action of the Disulfides of the Alkali Metals and of Sodium Tetrasulfide on Some Organic Halogen Compounds. See article.

410 **Troeger, J., and Eggert, A. B. A. 1896, i, 562.** *J. prakt. Chem.* [2] **53**, 478-83. Action of Thiophenol (Phenyl Hydrosulfide) on Aromatic Diketones. Benzyl heated with twice its weight of thiophenol and zinc chloride for 10 hours on the water bath, dioxobenzoin and phenyl bisulfide are produced. An additive compound also formed. Same type of reaction took place with parathiocresol and ethyl mercaptan.

411 **Troeger, J. and Horning, V. B. A. 1898, i, 257.** *J. prakt. Chem.* [2] **56**, 445-69. Action of Alcoholic Potassium Sulfide and Hydrosulfide on Symmetrical Dibromosulfones. Studied R · SO₂ · CH₂ · CH Br · CH₂Br with K₂S to form a sulfide (three membered ring) which would be oxidized to sulfone. Formed dimercaptan also. See abstract.

412 **Ulpiani, C., and Ciancarelli, U. B. A. 1904, i, 162.** *Atti. accad. Lincei* [5] **12**, ii, 219-28. Preparation of Aromatic Thio-acids and their Amides. Pass H₂S into 10% solution of benzoyl formic acid to prepare trithiophenylacetic acid. With zinc and HCl yields phenylacetic acid and H₂S. Bromine oxidizes it to benzoic acid. Thiophenyl acetic acid reduces ferric chloride to ferrous and forms dithiophenylacetic acid.

413 **Unger, O., and Graff, G. B. A. 1898, i, 96.** *Ber.* **30**, 2389-99. Action of α -Brominated Acids and Ketones on Orthamidothiophenol. Formation of rings with nitrogen and sulfur as part of the ring.

414 **van Hove, T. C. A. 1927, 2256.** *Bull. sci. acad. roy. Belg.* [5] **12**, 929-43. Direct Introduction of Groups into Aromatic Mercaptans. The SH group shown to have the same orienting tendencies as OH group.

415 **van Hove, T. C. A. 1928, 62.** *Bull. sci. acad. roy. Belg.* [5] **13**, 206-24. Direct Introduction of Substituting Groups in Aromatic Mercaptans. Bromination reactions are studied. SH has stronger influence on entering group than Me, weaker than OH.

416 **van Hove, T. C. A. 1928, 393.** *Bull. soc. chim. Belg.* **36**, 543-58. Direct Introduction of Substituent Groups into Aromatic Mercaptans. See article.

417 **van Hove, T. C. A. 1928, 1760.** *Bull. soc. chim. Belg.* **37**, 88-102. Direct Introduction of Substituents in Aromatic Mercaptans.* A correction to the bibliography of C. A. 1928, 62.

418 **van Hove, T. C. A. 1928, 3400.** *Bull. soc. chim. Belg.* **37**, 240. Direct Introduction of Substituents into Aromatic Mercaptans. Complementary Note.

419 **van Lenne, J. R. B. A. 1871, 369.** *Z. f. Chem.* [2] **7**, 67-71. On Bromosulfobenzoic Acid and its Derivatives. Monobromosulfobenzoic chloride reduced with tin and HCl to mercaptan. Forms salts. On reduction with sodium amalgam and water forms thiobenzoic acid. Also gives preparation of thiobrombenzoic acids and salts in Pb, Ba, Zn. These salts may be disulfides, not mercaptans.

420 **Vespignani, G. B. B. A. 1903, i, 545.** *Gazz. chim. ital.* **33**, i, 73-8. Critical Constants of Some Organic Substances. Measured b. p., sp. gr., critical temperature, critical pressure of methyl sulfide, ethyl sulfide, methyl ethyl sulfide and ethyl mercaptan.

421 **Vorlander, D., and Mittag, E. C. A. 1919, 2363.** *Ber.* **52B**, 413-23. Triphenylmethylsulfur Compounds. The preparation and properties of the mercaptan are given. Also its reaction with SO₂Cl₂, silver salts, acids and alkalies given.

422 **Votocek, E., and Vesely, V. C. A. 1914, 2716.** *Ber.* **47**, 1515-9. Resolution of Racemic Saccharides by Means of Optically Active Amyl Mercaptan, and Some Mercaptals. Give preparation of active mercaptan. Formation of many mercaptals given.

423 **Watermann, H. I., and Perquin, J. N. J. C. A. 1925, 3371.** *Brennstoff*

Chem. **6**, 255-7. Desulfurization of Petroleum Distillates with Silica Gel.

The sulfur reduction for the various sulfur compounds was: $(C_2H_5)_2S$, 33%; C_6H_5SH , 31%; C_6H_5CNS , 88%; C_6H_5NCS , 17% and $(C_2H_5)_2SO_4$, 100%.

424 Watermann, H. I., and Tussenbrock, M. J. van. *C. A.* **1928**, 2528. *Brennstoff-Chem.* **9**, 37-9. Desulfurizing Action of Silica Gel and the Failure of the Lamp for the Determination of Sulfur (in Oils) in the Presence of Mercaptans.

With sulfides 10% to 50% of the sulfur was removed by 7 hours treatment, removal being greatest with sulfides of low mol. wt. Mercaptan sulfur was diminished but the extent was not determined.

425 Watermann, H. I., and Tussenbrock, M. J. van. *C. A.* **1929**, 2816. *Brennstoff-Chem.* **9**, 397-8. The Desulfurizing Action of Silica Gel, III.

Results are given when definite concentrations of $(C_6H_5)_2S$, $(C_6H_5CH_2)_2S$ and $C_6H_5CH_2SH$ were dissolved in kerosene and treated with silica gel.

426 Weigert, F. *B. A.* **1902**, **i**, 10. *Ber.* **34**, 3386-3405. Trithiodibutylactone. Prepared by method of Gabriel and Day (*B. A.* 1890, 1249). On reduction forms bistetramethylene sulfide.

427 Weiss, R., and Knapp, W. *C. A.* **1929**, 1896. *Monatsh.* **50**, 392-8. Action of Phthalyl Chloride on *p*-Cresolmethylether and *p*-Thiocresolmethylether.*

428 Whitner, T. C., and Reid, E. E. *C. A.* **1921**, 1715. *J. Am. Chem. Soc.* **43**, 638-42. Some Derivatives of Butyl Mercaptan and their Mercuric Iodide Compounds.

Various mixed sulfides and mercaptol ethers were prepared. The actions of various reagents was also studied.

429 Willgerodt, C. *B. A.* **1885**, 519. *Ber.* **18**, 328-31. α -Dinitrophenylthiobenzoate and the Ethers of Dinitrophenylmercaptan.

Dinitrophenylthiobenzoate (2:4) is prepared by the successive action of potassium sulfide and benzoyl chloride on α -dinitrochlorobenzene. Decomposed with alkali. Nitric acid gives dinitro sulfonic acid. Ethers prepared of dinitrophenyl mercaptan.

430 Willgerodt, C. *B. A.* **1885**, 519. *Ber.* **18**, 331-3. Paranitrophenyl Mercaptan and Paranitrophenyl Disulfide.

Prepared by heating *p*-nitrochlorobenzene with aqueo-alcoholic solution of potassium sulfide and decomposing mercaptide formed with HCl. Very readily oxidized to disulfide. Formed silver, lead, copper and nickel mercaptides.

431 Winssinger, C. *B. A.* **1888**, 243. *Bull. soc. chim.* [2] **48**, 108-12. Propane Derivatives.

Propyl mercaptan, sulfide, sulfonic acid, oxysulfide, sulfone are discussed.

432 Winter, L. P. *B. A.* **1904**, **i**, 581. *Am. Chem. J.* **31**, 572-7. New Reducing Agent for the Preparation of Thiophenol.

Nearly quantitative yield affected by the action of stannous chloride in the presence of a small quantity of zinc dust in reducing benzenesulfonchloride.

433 Wood, A. E. *C. A.* **1925**, 2473. *J. Am. Chem. Soc.* **47**, 2062. Preparation of Alkyl Sulfides.

All the alkyl sulfides tested showed presence of mercaptans, their complete removal accomplished by distilling sulfides over finely divided Cu. Either the Cu mercaptide remains as residue or if heated to 125°, will decompose giving CuS and the sulfide.

434 Wuyts, H. *B. A.* **1903** **i**, 428. *Ber.* **36**, 863-70. Thio-derivatives of Camphor.

Forms disulfides and trisulfides. Prepared lead thioborneol.

435 Wuyts, H. *B. A.* **1906**, **i**, 257. *Bull. soc. chim.* [3] **35**, 166-9. Action of Disulfides on Organo-magnesium Haloids. Synthesis of Mixed Sulfides.

Phenyl disulfide and ethyl magnesium bromide yield on decomposition with water phenylethylsulfide and thiophenol. Other disulfides also studied.

436 Wuyts, Y., and Vangindertaelen, A. *C. A.* **1922**, 3077. *Bull. soc. chim. Belg.* **30**, 323-8. The Quadivalence of Tin in its Mercaptides.

Sn^{+++} mercaptides can be prepared: a. by action of Sn and HCl on org. disulfides with subsequent neutralization; b. from a thio-alcohol and $SnCl_2$ in presence of air, c. from a thio-alcohol and $SnCl_4$.

437 Zincke, T., and Frohneberg, W. *C. A.* **1909**, 2577. *Ber.* **42**, 2721-36. Dithiohydroquinol.

Its preparation and properties given. Br forms the disulfonyl bromide. The phenylene-1,4-methyl sulfide is given. Latter forms sulfoxide with HNO_3 and $HgCl_2$ salt with $HgCl_2$. Tetrabromide and tetraiodide prepared from sulfoxide. Other S compounds given.

438 Zincke, T., and Jorg, P. *C. A.* **1910**, 169. *Ber.* **42**, 3362-74. 1,4-Aminothiophenol.

Acetyl derivatives, methyl thioether, sulfoxide and dibromide are given. $FeCl_3$ converts 1,4-acetaminothiophenol into diacetodiamino diphenyl disulfide.

439 Zincke, T., and Frohneberg, W. *C. A.* **1910**, 1746. *Ber.* **43**, 837-48. p-Thiocresol.

Cl in glacial AcOH converts *p*-thiocresol into *p*-toluenesulfonyl chloride. With $FeCl_3$ in AcOH gives the disulfide. Sulfoxide and sulfone given, also $HgCl_2$ salt. Halogen substitution products of above are given.

440 Zincke, T., and Jorg, P. *C. A.* **1911**, 894. *Ber.* **43**, 3443-50. 1,4-Aminothiophenol, II.

Various derivatives and dyes are given by this compound.

441 Zincke, T., and Brune, R. *C.A. 1911*, 1439. *Ber.* 44, 185-97. Sulfur Derivatives of o-Cresol.
Certain substituted cresol sulfides, mercaptans, sulfoxides, and sulfones are given, also certain sulfonium compounds.

442 Zincke, T. *C.A. 1911*, 1914. *Ber.* 44, 769-71. New Series of Aromatic Sulfur Compounds.
The formation of new sulfur compounds by action of Cl on mercaptan benzyl ethers and on mercaptans or the disulfides is noted. p, p'-Dimercaptan dichloride and 4, 6-dichlorobenzene-1, 3-mercaptop dichloride were made by both methods. 1, 2-Nitrobenzenemercaptan chloride is given. Compound from Br and PhSSPh is $\text{BrC}_6\text{H}_4\text{SSC}_6\text{H}_4\text{Br}$ and not PhSBr as stated by Otto (*Ann.* 145, 329).

443 Zincke, T., and Dahm, A. *C.A. 1913*, 2392. *Ber.* 45, 3457-68. p, p'-Diphenyldimercaptan.
Various derivatives of the compound are given.

444 Zincke, T., and Ebel, C. *C.A. 1914*, 1781. *Ber.* 47, 923-33. 1-Phenol 3-Mercaptan.
Preparation, properties, and various derivatives given.

445 Zincke, T., and Ebel, C. *C.A. 1914*, 2164. *Ber.* 47, 1100-8. 1-Phenol 4-Mercaptan.
Preparation, properties, and various derivatives given.

CROSS REFERENCES

Group 1—116, 150; **Group 2**—17, 19, 36, 38, 47, 52, 56, 57, 60, 62, 68, 69, 81, 86, 92, 104, 106, 110, 111, 112, 113, 114; **Group 3**—5, 9, 13, 21, 22, 23, 25, 26, 31, 49, 52, 57, 71, 74, 80, 92; **Group 4**—9, 16, 18, 22, 23; **Group 5**—3, 18, 59, 62, 72, 81, 82, 87; **Group 6**—16, 21, 34, 35; **Group 7**—3, 9, 13, 26, 29; **Group 8**—6, 14, 27, 29, 33.

GROUP 11

MERCAPTIDES

1 Autenrieth, W. *B.A. 1890*, 361. *Ann.* 254, 222-52. Thio-derivatives of the Crotonic Acids.
Prepared from sodium chlorocrotonates and sodium mercaptides.

2 Autenrieth, W. *B.A. 1891*, 540. *Ber.* 24, 159-66. Derivatives of Acetal and Acetone.
Prepared thiophenyl and thioethyl acetal and also thiophenylacetone.

3 Autenrieth, W. *B.A. 1896*, i, 617. *Ber.* 29, 1639-52. Isomerism of the Crotonic Acids.
Sodium β -chloroisocrotonate heated in alcoholic solution with sodium benzylmercaptide forms benzyl disulfide and thio-benzylisocrotonic acid. Others prepared likewise.

4 Beckmann, E. O. *B.A. 1879*, 37. *J. prakt. Chem.* [2] 17, 439-77. Oxidation Products of Diethyl Sulfide and Analogous Compounds.
Prepared ethyl phenyl sulfide by heating sodium phenyl mercaptide in sealed tube with ethyl iodide. Prepared sulfones by oxidation with permanganate. Details of purification are given for each compound. Sulfones are stable; can be distilled. Not reduced by zinc and dilute sulfuric acid or HI. Not attacked by phosphorus pentachloride. Sulfoxides are reduced by reagents named and converted into sulfides by phosphorus pentachloride. See abstract or original.

5 Bourgeois, E. *B.A. 1891*, 1238. *Ber.* 24, 2264-7. Tolylnaphthyl Sulfides.
Heat bromtoluene with lead salts of naphthyl mercaptan at 225° for 6 hours.

6 Bourgeois, E. *B.A. 1896*, i, 17. *Ber.* 28, 2312-30. Action of the Mono-bromo-derivatives of the Aromatic Hydrocarbons on the Lead Salts of the Thiophenols.
Prepared aromatic sulfides.

7 Claesson, P. *B.A. 1877*, ii, 293. *J. prakt. Chem.* [3] 15, 174-6. Action of Sodium Mercaptan on Iodomethane, Methene Iodide and Chloroform.
Discusses sulfide prepared from mercaptide and methyl iodide. Get product from iodoform as well as methene iodide. Rather polemical against some work of Carius.

8 Delisle, A., and Schwalm, A. *B.A. 1893*, i, 35. (*cf.* 1889, 488). *Ber.* 25, 2980-4. Organic Sulfur Compounds.
Sulfides such as β -thioparatolyl propionic acid, α -hydroxy β -thiotolyl isobutyric acid, ethyl meta ethoxyphenyl thioacetato-acetate, and β -thiotolyllevalinic acid have been prepared from the halogen substituted acid and sodium salt of mercaptan. Meta ethoxyphenyl disulfide, m. p. 42°, prepared.

9 Gabriel, S. *B.A. 1877*, ii, 325. *Ber.* 10, 184. Disulfocyanobenzene.
Lead salt of thioresorcin digested at 100° with cyanogen iodide yields lead iodide and metadisulfocyanobenzene. Properties studied.

10 Gabriel, S. *B.A. 1880*, 33. *Ber.* 12, 1639-41. Derivatives of Thioacetic Acid.
Used chloracetic acid and aryl mercaptan in alkaline solution to form derivative of thioacetic acid.

11 Goldberg, I. B.A. 1905, i, 59. Ber. 37, 4526-7. A New Preparation of Alphylthiosalicylic Acid.
Potassium salt of thiophenol reacts with potassium o-chlorobenzoate at 220°-230° in presence of a small quantity of copper to form phenyl thiosalicylic acid.

12 Grindley, H. S., and Sammis, J. L. B.A. 1897, i, 403. Am. Chem. J. 19, 290-5. Action of Mercaptides on Quinones.
Dichlorodiphenoxquinone treated in ethereal solution with sodium ethyl mercaptide, tetraethioethylquinone is formed. Can be reduced with glacial acetic acid and zinc to quinol.

13 Helfrich, O. B., and Reid, E. E. C.A. 1920, 2486. J. Am. Chem. Soc. 42, 1208-32. Reactions and Derivatives of β, β' -Dichloroethyl Sulfide.
Action of oxidizing agents studied. Substituted aryl sulfides prepared.

14 Hoffman, K. A., and Rabe, W. O. B.A. 1898, i, 458. Z. anorg. Chem. 17, 26-34. Action of Alkylic Haloids on Mercaptides.
Warm cautiously mercury mercaptide and ethyl iodide and IHgSEt is formed. This compound was studied. See abstract.

15 Hofmann, K. A., and Wiede, O. F. B.A. 1895, ii, 451. Z. anorg. Chem. 9, 295-303. Nitroso-Compounds of Iron.
Dinitrosoferroethyl and phenyl mercaptides were prepared. Former melts at 78° and latter at 179°. Both are very stable. See abstract.

16 Jackson, C. L., and Oppenheim, A. B.A. 1876, i, 364. Ber. 8, 1032-4. Two Derivatives of Mercuric Mercaptide.
Boiling alcoholic solution of mercuric mercaptide and iodoform deposited on cooling compound of two molecules of mercury mercaptide and one of iodoform; decomposition in alcoholic solution complex.

17 Kehrmann, F., and Duttenhofer, A. C.A. 1907, 305. Ber. 39, 3559-60. Sulfine Sulfonum Bases of the Aromatic Series, II.
Dry aromatic Pb mercaptides react at 100° with alkyl sulfates forming ethers of mercaptans, which then add the alkyl sulfide forming sulfonium bases.

18 Kohler, E. P. B.A. 1899, i, 737. Am. Chem. J. 22, 67-80. Reaction Between Aliphatic Thiocyanates and Metallic Derivatives of Ethylic Acetoacetate and Analogous Substances.*

19 Krafft, F., and Bourgeois, E. B.A. 1891, 76. Ber. 23, 3045-9. Naphthyl Sulfides.
Compare B.A. 1890, 1311. Prepared from lead salt of naphthyl mercaptan and bromonaphthalene. Several aromatic sulfides prepared this way.

20 Lecher, H. C.A. 1920, 3078. Ber. 53B, 568-77. Phenylmercaptomercuric Chloride.

When shaken in alcohol with NaSEt it reacts as follows:

$$2\text{PhSHgCl} + 2\text{NaSEt} = 2\text{NaCl} + (\text{PhS})_2\text{Hg} + (\text{EtS})_2\text{Hg}$$

21 Mauthner, F. C.A. 1907, 306. Ber. 39, 3593-8. General Method of Preparing Aryl Sulfides.
Na mercaptide is treated with aryl iodide in presence of copper as catalyst. The physical properties of many aromatic sulfides are given.

22 Otto, R. B.A. 1880, 796. Ber. 13, 1289-90. Behavior of Ethyl Mercaptides of Mercury and Lead at High Temperatures.
Mercuric ethyl mercaptide (m.p. 76°) heated in alcohol at 180° splits to form disulfide, metallic mercury and only a trace of mercuric sulfide. When heated dry, somewhat more decomposition to mercuric sulfide. Lead ethyl mercaptide melts at 150° and decomposes at 180°, forming lead sulfide and ethyl sulfide.

23 Otto, R., and Rossing, A. B.A. 1890, 780. Ber. 23, 752-9. Preparation of Sulfones.
Continuation of work of R. and W. Otto, (B.A. 1888, 282). Many negative experiments given. Can use halogenated ketones and sodium mercaptides to prepare the sulfide. This can be oxidized, if carefully done, to sulfone with permanganate. Directions given.

24 Otto, R. B.A. 1890, 962. Ber. 23, 1051-2. Behavior of Sodiophenylmercaptide with Isobutylene Bromide.
Forms phenyl disulfide, isobutylene, and sodium bromide. Trimethylethylene bromide seems to behave in a similar manner.

25 Otto, R., and Rossing, A. B.A. 1891, 712. Ber. 24, 685-7. Action of Sodium Phenylmercaptide on Ethyl Chloracetacetate.
Repeating work of Autenrieth (B.A. 1891, 540).

26 Otto, R., and Troger, J. B.A. 1893, i, 167. Ber. 25, 3422-5. Synthesis of Symmetrical Diphenylsulfoneacetone by Means of Symmetrical Dichloracetone.
Boil dichloracetone in benzene for several days with sodium benzene sulfinate to form mono and diphenyl sulfoneacetone. Dithiophenyl acetone is made from Na thiophenylate and dichloracetone.

27 Otto, R. B.A. 1895, i, 96. Ber. 27, 3055-8. Vinyltriphenylsulfone (Triphenylsulfonethane).
Sym. trichlorethane warmed with sodium benzene sulfinate in alcoholic solution yields disulfone, not tri. When warmed with sodium phenyl mercaptide in alcoholic solution yields trithiophenylethane. Oil, odor that of lemons. Oxidized by permanganate yields disulfone. Oxidized cold yields trisulfone. Insol. in water, readily hydrolyzed by aqueous soda.

28 Otto, R. B.A. 1895, i, 286. J. prakt. Chem. [2] 51, 285-315. Homologs of Ethylenediphenylsulfone and Ethylenedithiophenylsulfone: Action of Halogen-alkylene Compounds on Mercaptides.

Prepared sulfone from alkyl halide and sodium sulfinate. Prepared thioethers by use of sodium thiophenol and propylidene chloride.

29 Otto, R., and Muhle, K. B.A. 1895, i, 422. Ber. 28, 1120-2. Preparation of Ethylenediphenylsulfone.
Prepared by oxidizing product from ethylenedichloride and sodium thiophenoxide with permanganate in acetic acid solution and removing manganese oxide with sulfuric anhydride.

30 Otto, R., and Muhle, K. B.A. 1895, i, 485. J. prakt. Chem. [2] 51, 517-21. Analogy Between the Behavior of Halogen Alkenes Toward Sodium and Like Metals, on the One Hand and Toward Mercaptides on the Other Hand. (See R. Otto. B.A. 1895, i, 286. Table is given in paper.) Showing the analogy between the behavior of alkyl halides toward sodium or sodium mercaptide. Both split out HX.

31 Otto, R. B.A. 1896, i, 242. J. prakt. Chem. [2] 53, 1-19. Behavior of Stilbene Dibromide and of Tolane Dibromide with Sodium Benzenesulfinate and Sodium Phenylmercaptide.
Neither halogen compound is converted into sulfone with sodium benzene sulfinate; instead stilbene and tolane are formed. Same occurs with sodium phenylmercaptide.

32 Pauly, C., and Otto, R. B.A. 1878, 414. Ber. 10, 2181-5. Formation and Constitution of Benzene and Paratoluene Disulfodioxides.
Benzene disulfodioxide and zinc phenylmercaptide in cold alcoholic solution forms diphenyl disulfide and zinc benzene-sulfinate. The constitution is then that both oxygens are on one sulfur.

33 Pauly, C., and Otto, R. B.A. 1879, 243. Ber. 11, 2070-2. Disulfoxides of Benzene and Toluene.
Sulfonic acids in atmosphere of CO_2 over sulfuric acid change to sulfonic acid and disulfoxide. See previous work.

34 Pauly, C., and Otto, R. B.A. 1879, 219. Ber. 11, 2073-5. Decomposition of Ethyl Disulfoxide by Potash.
Has the same decomposition as found with the aromatic (Ber. 11, 2070), giving with zinc, zinc ethyl sulfinate, and zinc ethyl mercaptide.

35 Pesci, L. B.A. 1899, i, 816. Gazz. chim. ital. 29 (i) 394-9. Mercuri-phenyl Sulfide and Thiosulfate.
Prepared from mercury phenyl acetate.

36 Ramberg, L. C.A. 1907, 2560. Ber. 40, 2588-90. Note on Ethylthioglycolic Acid.
Na mercaptide from ethyl mercaptan and concentrated aqueous NaOH yields sodium ethyl thioglycolate, when treated with a concentrated aqueous solution of sodium chloracetate.

37 Ray, P. C. C.A. 1916, 2582. J. Chem. Soc. 109, 603-12. Mercury Mercaptide Nitrites and their Reaction with Alkyl Iodides, II.

MeSHgNO₂ and MeI react to form $\text{MeS}_2 \cdot \text{HgI}_2 \cdot \text{MeI}$. Other alkyl halides show similar action.

38 Ray, P. C. C.A. 1917, 1422. J. Chem. Soc. 111, 101-9. Mercury Mercaptide Nitrites and their Reaction with Alkyl Halides. III, Chain Compounds of Sulfur.*

39 Rivier, H. C.A. 1907, 3004. Bull. soc. chim. [4] 1, 733-40. On the Phenylchlorothiocarbonates.
Prepared by action of phosgene in toluene on lead thiophenate and subsequent treatment with alcohol. Action of NH₃ and aniline also given.

40 Sachs, G., Schlesinger, L., and Antoine, H. C.A. 1924, 57. Ann. 433, 154-63. Organic Mercury Mercaptides.
Various Hg mercaptides and their constants are given.

41 Sachs, G. C.A. 1924, 3154. Z. anorg. allgem. Chem. 135, 283-8. Mercuric Oxyethyl Mercaptide.*

42 Sachs, G., and Balassa, L. C.A. 1925, 3069. Z. anorg. allgem. Chem. 146, 196-9. Colored Compounds of the Sulfide and the Mercaptide of Mercury.
2 HgS · Hg(SC₂H₅)₂ can be prepared by passing H₂S into an ethereal solution of Hg(SC₂H₅)₂. The compound exists in yellow and red modifications, the first being the stable one.

43 Schaeffer, A., and Muria, A. C.A. 1907, 2108. Ber. 40, 2007-8. ρ -Nitrobenzylmercaptals and Mercaptols.
Zn salt of ρ -nitrobenzylmercaptide used as a reagent for aldehydes and ketones. The aldehyde or ketone is added to an alcoholic solution of the mercaptide saturated with HCl gas. Various condensations reported.

44 Schiller, R., and Otto, R. B.A. 1877, i, 463. Ber. 9, 1637-8. Reactions of Aromatic Disulfides.
Phenyl disulfide and boiling alcoholic potash give potassium phenyl mercaptide and potassium sulfinate. Toluyl disulfide reacts same. Dry chlorine converts disulfides into substitution products of benzene, and in presence of water forms sulfonic chlorides and acids.

45 Schiller, R., and Otto, R. B.A. 1877, i, 469. Ber. 9, 1636-7. Experiments for Preparing the Thio Ethers of Benzenesulfonic and Paratoluene-sulfonic Acids.
Lead thiophenol mercaptide and phenylsulfonchloride gave di-phenyl disulfide and lead sulfinate.

46 Seifert, R. B.A. 1885, 1057. J. prakt. Chem. [2] 31, 462-80. Action of Sodium Mercaptide on Phenyl Salts.
Conclusions were that alcohol, mercaptan, phenol, and thiophenol form a series in which the basic properties decrease and the acid properties increase from left to right. Experiments were made with replacement of radicals in esters such as carbonates, acetates, and salicylates.

47 Troeger, J., and Hornung, V. *B. A. 1903*, i, 95. *J. prakt. Chem.* [2] 66, 345-52. Action of Phthalic Chloride on Arylsulfonates, Arylthiosulfonates and Arylmercaptides.

Phthalic chloride on potassium benzene thiosulfonate on p-toluene sulfonate in alcoholic solution leads to formation of the corresponding disulfides which are decomposed by the alcohol into a mixture of mono- and tri-sulfides. Sodium benzene-sulfinate yields biphenyl sulfonephthalide. Lead phenyl mercaptide yields biphenyl-thiophthalide. Thio is oxidized to the sulfone.

β -naphthyl sodium mercaptide yields β -naphthyl disulfide and bi- β -naphthyl thiophthalide.

48 Ziegler, J. H. *B. A. 1890*, 1292. *Ber. 23*, 2469-72. Preparation of Aromatic Sulfides and a Thioxanthone.

Prepared from sodium phenyl mercaptide and diazoderivatives.

CROSS REFERENCES

Group 2—19, 92; Group 5—82; Group 7—26; Group 8—6; Group 10—5, 17, 56, 64, 65, 85, 86, 88, 93, 106, 116, 126, 138, 139, 157, 158, 160, 161, 162, 190, 202, 203, 215, 216, 235, 236, 240, 248, 257, 258, 261, 263, 279, 284, 286, 288, 297, 309, 335, 337, 338, 339, 341, 342, 344, 346, 348, 353, 359, 367, 368, 393, 397, 405, 419, 428, 430, 434, 436.

GROUP 12

DISULFIDES

1 Auwers, K., and Schumann, C. *B. A. 1902*, i, 147. *Ber. 34*, 4267-82. Nitro- and Thio-cyanopseudophenols and Cyanophenols.

Prepared sulfide, disulfides, and thiocyanate derivatives of dibromo p-hydroxy Ψ -cumene.

2 Banerjee, M. N. *C. A. 1914*, 305. *Z. anorg. Chem.* 83, 113-8. Action of Sulfides on the Allyl Group on Lead Amalgam and Mercury.

Action of oil of garlic on lead amalgam gives HgS and PbS due to decomposition of $(C_3H_5)_2S_2$ to $(C_3H_5)_2S$.

3 Bennett, G. M. *C. A. 1921*, 2061. *J. Chem. Soc.* 119, 418-25. β , β' -Dichlorodiethyl Disulfide.*

4 Bennett, G. M., and Berry, W. A. *C. A. 1925*, 2027. *J. Chem. Soc.* 127, 910-1. Ray's Supposed Triethylene Trisulfide.

Substance was shown to be Et_2S_2 .

5 Bergmann, M. *C. A. 1920*, 3416. *Ber. 53B*, 979-84. Action of Benzoyl Chloride on Potassium Sulfide.

Among the products formed were Bz_2S_2 , benzalbisthiobenzoate, Bz_2S , $BzOEt$, $BzOK$ and some $BzSK$.

6 Biielman, E. *C. A. 1909*, 1521. *Ann. 364*, 314-29. Organic Thio-acids.

Several dithiocarboxy fatty acids are given. They are prepared by treating the xanthogen fatty acid with the brom fatty acid in CO_2 for 3½ hours at 120°-122°.

7 Billiter, O. *B. A. 1875*, 464. *Ber. 7*, 1753-6. Phenyl Sulfocyanate.

Best to prepare from lead thiomercaptide and cyanogen chloride, b. p. 231°. Decomposes with hydrochloric acid.

8 Binz, A. *B. A. 1904*, i, 964. *Ber. 37*, 3549-50. Action of Methyl Sulfate on Sodium Hyposulfite.

Prepared methyl sodium thiosulfate on heating methyl sulfate and sodium hyposulfite at 70° for a few minutes. If heating is continued at 70° with reflux sulfur dioxide, methyl sulfide and methyl disulfide are formed. If heated at 200°, dimethyl sulfone is formed.

9 Binz, A., and Marx, T. *C. A. 1908*, 381. *Ber. 40*, 3855-60. On Our Knowledge of Hydrosulfites.

Sodium hydrosulfide and benzoyl chloride yield benzoic anhydride and benzoyl disulfide. In presence of pyridine there are formed 2 bases in addition to above. Na_2S and benzoyl chloride yield benzoyl disulfide.

10 Blanksma, J. J. *B. A. 1900*, i, 226. *Proc. K. Akad. Wetensch. (Amsterdam).* 2, 271-2. Action of Sodium Mono and Disulfides on Aromatic Nitrocompounds.

Replaces one of the nitro groups of o-dinitro-, and chlorine from p-chloronitrobenzene. Both sulfides and disulfides can be prepared.

11 Blanksma, J. J. *B. A. 1900*, i, 482. *Rec. trav. chim.* 19, 111-4. General Method for Preparing Sulfonic Derivatives of Means of Disulfides.

Replace bromine with disulfide and then oxidize. Aromatic (substituted) as well as aliphatic.

12 Blanksma, J. J. *B. A. 1901*, i, 460. *Rec. trav. chim.* 20, 121-40. Substitutions and Transformations Affected by Sodium Disulfide.

Preparation of disulfides—aliphatic and aromatic.

13 Blicke, F. F. *C. A. 1923*, 3499. *J. Am. Chem. Soc.* 45, 1965-9. Spontaneous Dissociation of Triphenylmethyl-disulfide with the Formation of Triphenylmethyl. The Potassium Derivative of Triphenylcarbinol and its Use as Synthetic Reagent.*

14 **Brand, K. C. A.** 1910, 176. *Ber.* **42**, 3463-8. Thiophenols. I. o-Azothianisole and o-Thiodianisidine. o-Nitrothianisole prepared from o-dinitrophenyl disulfide by action of NaOH and NaSH, Na₂S or Na₂S₂, and subsequent treatment with Me₂SO₄. o-Azothianisole prepared by electrolytic reduction of o-nitrothianisole. Reduced to o-hydrazothianisole. Concentrated HCl hydrolyzes latter to o-thiodianisidine.

15 **Brand, K., and Vogt, W. C. A.** 1924, 2513. *J. prakt. Chem.* 383-90. Thiophenols. VII, A Simple Method of Preparation of ρ -Methylmercapto- and ρ , ρ' -Dimethylmercapto-triphenylcarbinol. Prepared by action of Ph₂CCl₂ on PhSMe dissolved in CS₂ and in the presence of AlCl₃.

16 **Brooker, L. G. S., Child, R., and Smiles, S. C. A.** 1927, 2885. *J. Chem. Soc.* 1927, 1384-8. Aromatic Disulfonyl Disulfides. The sulfonyl disulfides are prepared as follows: ArSO₂SNa + SClAr (in Et₂O) = NaCl + ArSO₂S₂Ar. The reactions of these with various reagents are discussed.

17 **Bugge, G., and Bloch, I. C. A.** 1911, 1268. *J. prakt. Chem.* **82**, 512-9. Persulfides of Aldehydes. The disulfide and trisulfide hydroxides of dibenzylidene, dianisylidene, and dicinnamylidene are given. Additive compounds of salicylaldehyde could not be obtained pure.

18 **Cassirer, H. B. A.** 1893, i, 16. *Ber.* **25**, 3018-30. Orthocyanato- and Orthonitro-benzylchloride. Prepared ethoxyorthotoluothiamide, m. p. 84°, phenoxyorthotoluothiamide, orthobenzylthiamide, m. p. 153°, from corresponding nitrile. Orthonitrobenzylthiocyanate, m. p. 75°, from chloride and KSCN. Reduced to orthoamine by refluxing with stannous chloride and HCl. Thiocyanate dissolved in alcoholic ammonia and H₂S passed in probably forms orthonitrobenzyl disulfide.

19 **Chugaev, L., and Koblinskii, K. C. A.** 1913, 3935. *Z. anorg. Chem.* **82**, 8-26. Electrical Conductivity of Some Organic Disulfide Platinum Compounds.*

20 **Chugaev, L., and Chlopin, V. C. A.** 1913, 3935. *Z. anorg. Chem.* **82**, 401-19. Compounds of Plato-nitrites with Organic Dithioethers.*

21 **Chugaev, L., and Ivanov, C. C. A.** 1924, 3151. *Z. anorg. allgem. Chem.* **135**, 153-60. Complex Compounds of Palladium with Organic Mono- and Di-sulfides. Pd compounds are compared with Ni and Pt, NH₃ and amino derivatives being used.

22 **Coblenz, V. B. A.** 1891, 1216. *Ber.* **24**, 2131-6. Seleno and Thio-derivatives of Ethylamine and Propylamine.

Compare Gabriel and Lamar (*B. A.* 1890, 472). Prepared from phthalimide. Did not isolate the free amine salts.

23 **Coblenz, W., and Gabriel, S. B. A.** 1891, 817. *Ber.* **24**, 1122-5. Dithioethylamine. Formation of (NH₂C₂H₄)₂ · 2HCl and derivatives.

24 **Coninck, W. O. de. B. A.** 1898, i, 548. *Compt. rend.* **126**, 838-40. Decompositions of Alkylic Thiocyanates. Methyl thiocyanate with bleaching powder yields methylsulfonic acid. Ethylthiocyanate is not as readily attacked and forms some sulfuric acid. If no hypochlorite is present, the disulfide is formed. Others studied also. See abstract.

25 **Cooke, W. H., Heilbron, I. M., and Walker, G. H. C. A.** 1926, 192. *J. Chem. Soc.* **127**, 2250-5. Mesothianthracene Derivatives. II, Dianthranyl Disulfide and Dianthranyl Tetrasulfide. Preparation and properties given.

26 **Davies, S. H. B. A.** 1892, 300. *Ber.* **24**, 3548-52. Alkyl and Acidyl Sulfides. Methyl bisulfide or tersulfide heated at 100° for 3 to 4 hours with methyl iodide gives compound trimethyl sulfonium iodide. Thioacetic anhydride was also prepared. Correction to the abstract, *B. A.* 1892, 581.

27 **Dewar, J. B. A.** 1873, 74. *Pharm. J. Trans.* [3] **3**, 144. Cystine. Studied action of nitrous acid in cystine. Discuss formula.

28 **Ekbom, A. B. A.** 1891, 567. *Ber.* **24**, 335-8. Metadinitrodiphenyl disulfide. Heat metanitrobenzenesulfonic chloride in acetic acid with HI (sp. gr. 1.5) for 2½ hours on water bath. Yield 50%. Can be reduced by HI or sulfuric acid to metadinitrodiphenyl disulfide.

29 **Engle, W. D. B. A.** 1899, i, 3. *J. Am. Chem. Soc.* **20**, 668-78. Action of Metallic Thiocyanates on Aliphatic Chlorhydrins. Prepares mono- and di-thiocyanhydrins. Studies these products.

30 **Fichter, F., and Wenk, W. C. A.** 1912, 2609. *Ber.* **45**, 1373-83. Electrolytic Oxidation of Organic Sulfur Compounds. The methods employed for the oxidation of EtSNC and various sulfides given.

31 **Fichter, F., and Braun, F. C. A.** 1914, 2716. *Ber.* **47**, 1526-34. Electrolytic Oxidation of Organic Sulfur Compounds, III.*

32 **Fischer, E., and Suzuki, U. B. A.** 1905, i, 30. *Ber.* **37**, 4575-81. Synthesis of Polypeptides. VII, Derivatives of Cystine.*

33 **Footner, H. B., and Smiles, S. C. A.** 1926, 747. *J. Chem. Soc.* **127**, 2887-91. Reactions of Organic Thiosulfates.*

34 **Franchimont, A. P. N., and Klobbie, E. A.** *B.A.* 1887, 468. *Rec. trav. chim.* 5, 274-80. Amides of Ethylsulfonic Acid.
Prepared ethylsulfonic acid from ethyl disulfide. Prepared substituted sulfonamides.

35 **Fries, K., and Schurmann, G.** *C. A.* 1914, 2382. *Ber.* 47, 1195-203. Reduction of the Sulfinic Acids by Means of Hydrogen Bromide.
Aromatic sulfinic acids react in general with HBr with separation of Br and formation of aryl sulfur bromides or aryl disulfides. See abstract.

36 **Fromm, E., and Mangler, G.** *B.A.* 1901, i, 184. *Ber.* 34, 204-17. Ethenyltrisulfide (Tetraethenylhexasulfide) and its Derivatives.
The sulfide formed by the action of zinc chloride on thioacetic acid has the formula $C_6H_{12}S_8$ and the sulfone, $C_6H_{12}O_2S_6$. The sulfide is stable toward alkalis, alkyl halides and acetic anhydride, and the disulfone is not oxidized further by chromic acid or by nitric acid. Sulfide brominated. Derivatives prepared.

37 **Fromm, E., and Achert, O.** *B.A.* 1903, i, 340. *Ber.* 36, 534-46. Benzyl Derivatives Containing Sulfur and their Decomposition by Dry Distillation.
When benzyl sulfide is distilled under ordinary pressure yields H_2S , toluene, stilbene, thionessol (tetraphenylthiophene) and *s*-tetraphenylbutane. Benzyl disulfide gives the same product with the addition of sulfur. Benzyl sulfoxide does not give definite products. Benzyl sulfone decomposes only partially yielding SO_2 , toluene and stilbene. See abstract.

38 **Fromm, E.** *B.A.* 1906, i, 656. *Ann.* 348, 144-60. Unsaturated Disulfides.
Unsaturated of type, dibenzoyl sulfide, etc.

39 **Fromm, E.** *C.A.* 1909, 653. *Ber.* 41, 4385. Benzaldehyde Sulfoxylate. A Correction.
Benzaldehyde sulfoxylate, $C_7H_7SO_3Na$, benzyl chloride, and $NaOH$ give some benzyl disulfide and sodium benzylsulfonate, $C_8H_9SO_4Na$, not unchanged benzaldehyde sulfoxylate as stated by Fromm and Gaupp.

40 **Fromm, E., and Jorg, H.** *C.A.* 1925, 1557. *Ber.* 58B, 304-9. Derivatives of Monothioethyleneglycol.
Sulfides, disulfides, and sulfones were prepared.

41 **Genvresse, P.** *B.A.* 1897, i, 240. *Bull. soc. chim.* [3] 15, 409-26. Aromatic Disulfides.
When diphenylene disulfide is heated with strong sulfuric acid containing 60% anhydride, a substance is finally isolated which is regarded by the author as trihydroxyphenyl disulfide. Prepared other disulfides and disulfones from the disulfides.

42 **Gibson, D. T., Graham, H., and Reid, J.** *C.A.* 1923, 2279. *J. Chem. Soc.* 123, 874-81. Organic Compounds Containing Sulfur. I, The Effect on General Absorption Due to the Valency and Mode of Linkage of the Sulfur Atoms.
Absorption spectra of Ph_2S_2 , $Ph_2S_2O_2$, $Ph_2S_2O_4$, Ph_2S , Ph_2SO , Ph_2SO_2 , $(PhCH_2)_2S_2$, $(PhCH_2)_2SO$, $(PhCH_2)_2SO_2$, thianthrenethianthrene sulfoxide, 1, 4-thioxane, $(C_2H_4)_2S_2$, $(C_2H_4)_2S_2O_2$, $PhSO_2H$, $PhSO_2Na$ and $PhMeSO_2$ given.

43 **Gilman, H., and King, W. B.** *C. A.* 1925, 1562. *J. Am. Chem. Soc.* 47, 1136-43. Some Reactions of Substituted Mercapto-magnesium Halides.
The $-SMgX$ group can be identified satisfactorily by acylating agents, alkyl sulfates, RX compounds and $PhNCO$. Certain sulfides given.

44 **Giua, M., and Ruggeri, A.** *C. A.* 1923, 3865. *Gazz. chim. ital.* 53, 290-6. A New Method of Preparation of Some Aromatic Sulfides.
The method consists in a substitution of a labile NO_2 group of aromatic NO_2 derivatives with a sulfur atom by the action of thiourea.

45 **Graebe, C.** *B.A.* 1875, 274. *Ann.* 174, 177-210. Formation of Diphenyl Compounds Within the Molecule.
Phenyl sulfide passed through a red hot tube forms diphenylene sulfide. Diphenyl disulfide is partly decomposed at 300° into phenyl sulfide, sulfur and a smear.

46 **Gutmann, A.** *C.A.* 1924, 1115. *Ber.* 56B, 2365-7. Remarkable Behavior of Organic Sulfur Compounds Towards Tertiary Sodium Arsenite.
The compounds react in 2 ways: 1. some give up one or more atoms of sulfur directly as such to Na_3AsO_3 and KCN to give Na_2AsO_3 and $KSCN$; 2. others give up O_2 to Na_2AsO_3 although they themselves do not contain any, decomposing in the presence of water into 2 parts which then add the H_2 of H_2O while the O adds to the Na_3AsO_3 . The compounds give neither S nor O_2 to KCN . It is suggested the former contain the sulfur in the polysulfide form $-S-$, the latter in the persulfide form $-S:S-$.

47 **Hilditch, T. P., and Smiles, S.** *C.A.* 1907, 2796. *J. Chem. Soc.* 1907, 1394-9. The Influence of Mercuric Iodide on the Formation of Sulfonium Iodides.
Speed of reaction between alkyl halides and alkyl disulfides to form sulfonium halides greatly increased by presence of HgI_2 . Reactions occur at ordinary temperature. Triethyl sulfonium iodide is formed in excellent yield in 3 days in presence of HgI_2 . Absence of latter requires about 3 years and then gives small yield.

48 **Hilditch, T. P., and Smiles, S.** *C.A.* 1908, 536. *Proc. Chem. Soc.* 23, 206. and *J. Chem. Soc.* 1394, 91-2. The Influence of Mercuric Iodide on the Formation of Sulfonium Iodides.
Ethyl disulfide and ethyl iodide at ordinary temperatures give triethyl sulfonium iodide. The reaction is accelerated by presence of mercuric iodide. In this way the sulfonium salt can be isolated before secondary reactions of the alkyl halide set in.

49 Hilditch, T. P. C.A. 1911, 1599. *J. Chem. Soc.* **97, 2579-91. Intermolecular Condensation of Aromatic Sulfinic Acids, I.** The chloride of aromatic sulfinic acids under certain given conditions condenses, giving disulfoxides if p-position to sulfinyl group is open. If occupied, only small amounts of disulfoxide are formed. When heated, sulfinyl chlorides and disulfides may occur with, or in place of, the disulfoxides.

50 Hilditch, T. P. C.A. 1911, 3558. *J. Chem. Soc.* **99, 1091-1100. Intramolecular Condensation of Aromatic Sulfinic Acids. II, The Interaction of Aromatic Disulfoxides and Sulfuric Acid.** Decomposition is dependent upon the number and position of alkyl substituents in the aromatic nucleus. Primary reaction can only be explained by supposing that disulfoxide mol. undergoes hydrolytic fission with formation of sulfinic and sulfoxinic acids. See abstract.

51 Hinsberg, O. C.A. 1910, 2808. *Ber.* **43, 1874-9. Behavior of Aromatic Disulfides at High Temperatures.** Heated 1 hour at 280°, Ph_2S_2 gave a little PhSH , but mostly Ph_2S and Ph_2S_3 . No free sulfur was produced, contrary to statements in literature. Heated 1.5 hours at 260°-270° α -naphthyl disulfide forms mixture of naphthyl mono- and tri-sulfides. Dithiosalicylic acid yields o-carboxy diphenyl sulfide and trithiosalicylthioanhydride.

52 Hinsberg, O. C.A. 1913, 81. *Ber.* **45, 2337-9. Illumination of Sulfoxides and Sulfides.** (β - $\text{C}_{10}\text{H}_7\text{S}$)₂ in glacial AcOH with enough CaH_2 to make clear solution on warming, exposed to sunlight 4 to 6 weeks with a little I in loosely stoppered vessels, is oxidized to a small extent to dimethyl disulfide. (PhCH_2)₂S gives (PhCH_2)₂SO.

53 Hohn, F., and Bloch, I. C.A. 1911, 1266. *J. prakt. Chem.* **82, 486-511. Dithio Acids—Carbithionic Acids.** The preparation and properties of phenyl-, p-hydroxyphenyl-, and p-methoxyphenyl-carbithionic acids are given. Their salts and certain esters given. Action of oxidizing agents studied.

54 Houben, J., and Pohl, H. C.A. 1907, 1693. *Ber.* **40, 1303-7. Carbithioic Acids. II, The Thioacetic Acid, MeCSSH.** Formed by action CS_2 on methyl magnesium iodide. Reddish yellow oil, nauseous odor, insoluble in water, stronger acid than acetic. Oxidized in air to thioacetyl disulfide. Salts of many metals given.

55 Jahoda, R. B.A. 1890, 487. *Monatsh.* **10, 874-83. Orthonitrobenzylsulfide.** Oxidized to sulfoxide and sulfone. Prepared disulfide also.

56 Johnson, T. B. C.A. 1907, 55. *J. Am. Chem. Soc.* **28, 1454-61. Researches on Thiocyanates and Isothiocyanates.**

Thiocyanates react with thiobenzoic and thioacetic acids to form dithiocourethanes or thiol esters. Isothiocyanates react to form substituted acid amides. Reactions with phenylthioacetic, m-bromothiobenzoic, p-bromothiobenzoic and m-nitrothiobenzoic acids given.

57 Klinger, H. B.A. 1882, 1058. *Ber.* **15, 861-5. Sulfonybenzene.** "Sulfonybenzene" of Fleischer (*Ann.* **140**, 234) prepared by excess KSH on benzal chloride is benzyl bisulfide. Benzaldehyde is first formed which splits up into benzyl disulfide and dithiobenzoic acid.

58 Konek, F. V. C.A. 1921, 845. *Ber.* **53B, 1666-71. Organic Disulfides.** The reactions of various disulfides with Hg given. Comparisons are made.

59 Lecher, H. C.A. 1920, 3079. *Ber.* **53B, 577-90. Problem of the Valence of Sulfur, III.***

60 Levi, T. G. C.A. 1924, 1114. *Atti. accad. Lincei* [5] **32, i, 569-72. Dithioformic Acid.** The acid, its K, Ag, Pb salts and disulfide are given.

61 Major, R. T. C.A. 1927, 2876. *Bull. soc. chim.* **41, 634-7. An Aminobenzoic Ester of Thiodiglycol and its Sulfone. A New Higher Homolog of Thiodiglycol.** Method of preparation given.

62 Mayer, F. C.A. 1909, 2129. *Ber.* **42, 1132-7. Thiosalicylic Acid and Thioxanthone.** At 140°, Ac_2O converts thiosalicylic acid into phenyl sulfide, and thioxanthone. Dithioxanthylene is prepared from thioxanthone.

63 McKittrick, D. S. C.A. 1929, 3565. Ind. Eng. Chem. **21**, 585-92. Sulfur Compounds in Pressure-cracked Naphtha and Cracked Naphtha Sludge.

Thiophene and its 2-Me, 3-Me, 2, 3-dimethyl, 3, 4-dimethyl, 2-Et, and 3-Et derivatives were isolated from Midway crude oil (California) in the form of their mercurichloride compounds. Other sulfur compounds given.

64 Naik, K. G. C.A. 1921, 2072. *J. Chem. Soc.* **119, 379-85. The Formation and Properties of Dithioketones ($\text{R}_2\text{C:S:S}$) and Dithioethers ($\text{R}_2\text{S:S}$).** Object of study was to show to what degree the instability of the dithio group was affected by mol. condition of the remainder of the molecule and to compare relative stability shown by corresponding dithioketones.

65 Naik, K. G. C.A. 1921, 3621. *J. Chem. Soc.* **119, 1231-42. Formation and Properties of Dithioketones ($\text{R}_2\text{CS:S}$) and Dithioethers ($\text{R}_2\text{S:S}$), II.** Many compounds given. See abstract for details.

66 Nietzki, R., and Bothof, H. B.A. 1895, i, 132. *Ber.* **27, 3261-3. Thioaniline.** Parannitrochlorobenzene in alcoholic solution is heated with sodium sulfide; a

product is formed which on reduction with zinc and acetic acid gives thioaniline (see K. A. Hofman, *B. A.* 1895, 1, 87).

67 Otto, R. B. A. 1882, 831. *Ber.* 15, 121-32. Synthesis of So-called Alkyl Disulfoxides.
Prepared by the action of the salt of thioalkylsulfonate and alkyl halide. The thioalkylsulfonate is prepared from oxidation of disulfide to sulfonic acid, which is converted to the chloride with phosphorus pentachloride. Gives method of purification of ethyl thiosulfonate. Can be steam distilled. Decomposes in alkali. See abstract or original.

68 Otto, R. B. A. 1894, i, 35. *Ber.* 26, 2050-3. Dependence of Chemical Reactions on the Presence of Water.
Notes Baker's (*Proc. Chem. Soc.* 1893, 129) work on influence of water on chemical changes. States that benzenesulfonechloride, phenyldisulfoxide, phenyldisulfide, paratoluenesulfonechloride, and benzenesulfonic acid, whilst easily reduced by hydrogen in presence of water, are not attacked if water is absent.

69 Pope, W. J., and Smith, J. L. B. C. A. 1921, 2061. *J. Chem. Soc.* 119, 396-400. The Interaction of Sulfur Monochloride and Substituted Ethylenes.

70 Price, T. S., and Twiss, D. F. *Proc. Chem. Soc.* 1906, 260. The Electrolytic Preparation of Dialkyl Disulfides. Preliminary Note.
Electrolyzed concentrated aqueous solution of ethyl sodium thiosulfate and prepared diethyl disulfide.

71 Price, T. S., and Twiss, D. F. C. A. 1907, 178. *Proc. Chem. Soc.* 22, 260. The Electrolytic Preparation of Dialkyl Disulfides.
Electrolysis of concentrated solutions of ethyl sodium thiosulfate gave 50% yield of diethyl disulfide. Latter forms a compound with AgNO_3 . $(\text{C}_2\text{H}_5)_2\text{S}_2 \cdot \text{AgNO}_3$. Benzyl sodium thiosulfate gives an 80% yield of the corresponding sulfide, which also forms a compound with AgNO_3 .

72 Price, T. S., and Twiss, D. F. C. A. 1908, 816. *Proc. Chem. Soc.* 23, 263. Electrolytic Preparation of Disulfides. I, Dibenzyl disulfide and Diethyl disulfide.
Electrolysis of alkyl thiosulfates in divided cells favors formation of disulfides. A low current density with current in slight excess of theoretical, and use of concentrated solutions containing sodium carbonate or bicarbonate give most favorable yields.

73 Price, T. S., and Twiss, D. F. C. A. 1908, 1001. *J. Chem. Soc.* 91-2, 2021-31. Electrolytic Preparation of Disulfides. I, Dibenzyl disulfide and Diethyl disulfide.
No abstract given. See *C. A.* 1908, 816.

74 Price, T. S., and Twiss, D. F. C. A. 1908, 3064. *Proc. Chem. Soc.* 24, 179; *J. Chem. Soc.* 93, 1395-1400. Preparation of Disulfides. II, The Action of Alkalies on Sodium Alkyl Thiosulfates.

Alkalies and NaEt and $\text{Na benzylthiosulfates}$ yielded the corresponding disulfides, chiefly. Some oxidation also took place.

75 Price, T. S., and Twiss, D. F. C. A. 1908, 3064. *J. Chem. Soc.* 93, 1401-5. The Preparation of Disulfides. III, The Nitrobenzyl disulfides.
Electrolysis of the 3 sodium nitrobenzyl thiosulfates did not yield the desired disulfides. Na_2CO_3 on the thiosulfates gave pure disulfides slowly. NaOH formed some substances more rapidly but less pure. p -Nitrobenzylchloride boiled with $\text{Na}_2\text{S}_2\text{O}_3$ in H_2O gave p -nitrobenzylthiosulfate, which with Na_2CO_3 gave p -nitrobenzyl disulfide. o - and m -Compounds also given.

76 Price, T. S., and Twiss, D. F. C. A. 1909, 653. *Ber.* 41, 4375-8. Action of Alkalies on Sodium Alkyl Thiosulfates.
Article tends to confirm earlier work (*C. A.* 1908, 3064).

77 Price, T. S., and Twiss, D. F. C. A. 1909, 2680. *J. Chem. Soc.* 93, 1645-53. Preparation of Disulfides. IV, Esters of Dithiodiglycollic and Dithiodilactic Acids.
The preparation of the ethyl esters of the above acids is given.

78 Price, T. S., and Twiss, D. F. C. A. 1909, 2805. *J. Chem. Soc.* 95, 1050-5. Preparation of Disulfides. V, Diethyl Esters of α -Dithiobutyric, α -Dithiodisobutyric and α -Dithiodiisovaleric Acids.
Prepared by electrolytic reduction of the mixture obtained from the interaction of $\text{Na}_2\text{S}_2\text{O}_3$ and the esters of halogen substituted acetic and propionic acids.

79 Price, T. S., and Twiss, D. F. C. A. 1910, 195. *J. Chem. Soc.* 95, 1489-91. Preparation of Disulfides. VI, Note on a New Method of Preparing Disulfides.
A 99% of crude dibenzyl disulfide was obtained by heating 5 g. benzyl chloride, 10 g. $\text{Na}_2\text{S}_2\text{O}_3$, 30 cc. water and 30 cc. 95% EtOH for 1 hour on water bath. I is added slowly until color persists. Cool, dilute with water, and remove excess I with H_2SO_4 . Di- o -nitrobenzyl disulfide and dimethyl dithiodiglycolate prepared similarly.

80 Price, T. S., and Twiss, D. F. C. A. 1910, 199. *Proc. Chem. Soc.* 25, 36. Preparation of Disulfides. III, The Nitrobenzyl Disulfides. (Correction.)
A recent communication (*C. A.* 1908, 3064) claimed that the 3 sulfides had not been isolated. This is erroneous for o - and m -compounds. The method is new.

81 Schonberg, A., Schutz, O., and Peter, J. C. A. 1929, 3216. *Ber.* 62B, 440-1. Organic Sulfur Compounds. XII, Formation of Mercaptoles by the Action of Aliphatic Diazo Compounds on Disulfides. (Preliminary Communication.)*

82 Semmler, F. W. B. A. 1893, i, 103. Arch. Pharm. 230, 434-43. Essential Oil of Garlic (*Allium Sativum*).

Oil on fractionation at 16 mm. gave allylpropyldisulfide, diallyldisulfide, and 2 higher boiling fractions not identified.

83 **Sen, M., and Ray, J. N. C. A. 1926, 2681.** *J. Chem. Soc.* **1926**, 1139-42. Synthesis in the Thianthrene Series, II. 1,4,5,8-tetramethylthianthrene prepared. The disulfide and sulfone and certain dyes are given.

84 **Smiles, S., and McClelland, W. C. A. 1922, 1226.** *J. Chem. Soc.* **121**, 86-90. Interaction of Aromatic Disulfides and Sulfuric Acid. 2-Carboxyphenyldithioglycollic acid results by the action of $(HO_2C C_6H_4S^-)_2$ in conc. sulfuric acid. Properties given.

85 **Spring, W., and Legros, E. B. A. 1883, 47.** *Ber.* **15**, 1938-40. Alkylthiosulfuric Acids. Prepared ethyl, methyl (*Ber.* **7**, 646 and 1162; *Ber.* **15**, 946) propyl, primary isobutyl and amyl thiosulfuric acids. Crystallize well. Soluble in H_2O and $EtOH$. Decompose to form disulfides, sodium sulfate and SO_2 . With allyl and isopropyl iodides, obtain allyl and isopropyl disulfides.

86 **Spring, W., and Lecrenier, A. B. A. 1888, 664.** *Bull. soc. chim.* **48**, 629-30. Constitution of Guthrie's Chlorethylsulfide. Is $S_2(CH_2CH_2Cl)_2$.

87 **Steinkopf, W., and Muller, S. C. A. 1924, 525.** *Ber.* **56B**, 1926, 301. Action of Methyl Iodide on Disulfides. Me_2S_2 and MeI react to give not only Me_3Si but also Me_3Si_2 . Authors believe the reaction analogous to that between the cacodilys and MeI .

88 **Strzelecka, M. C. A. 1911, 1601.** *Kosmos* **35** (*Rad. Festb.*) 585-9. Action of Ammonia on Aromatic Thiocyanates. Action of alc. NH_3 on aromatic thiocyanates from NH_4 cyanate and a disulfide. Benzyl, o-, m-, and p-xylyl disulfides were thus prepared.

89 **Thiele, J., and Dimroth, O. B. A. 1899, i, 426.** *Ann.* **305**, 102-23. Orthonitrobenzyl Chloride and Paranitrobenzyl Chloride. Diamidodibenzylidisulfide prepared by the action of H_2S on the alcohol.

90 **Vaillant, V. B. A. 1896, i, 265.** *Bull. soc. chim.* [3] **15**, 514-9. Some Metallic Derivatives of Dithioacetylacetone. Forms potassium, Mg, Co, and other salts.

91 **Vaillant, V. B. A. 1899, i, 415.** *Bull. soc. chim.* [3] **19**, 246-9. Action of Ammonia on Dithioacetylacetone.*

92 **Vaillant, V. B. A. 1899, i, 594.** *Bull. soc. chim.* [3] **19**, 692-4. Action of Aniline on Dithioacetylacetone.*

93 **Youtz, M. A., and Perkins, P. P. C. A. 1928, 2266.** *Ind. Eng. Chem.* **19**, 1247-50. Action of Refining Agents on Pure Sulfur Compounds. Solutions of pure hydrocarbon sulfides, disulfides, and thiophenes in straight run naphtha were made up of such concentration as to contain 0.5% sulfur. Various refining reagents were studied. Results given.

94 **Zinke, T., and Glahn, W. C. A. 1907, 2472.** *Ber.* **40**, 3039-49. Attempts to Prepare Quinoidal Sulfur Compounds. The reactions of various sulfur bearing compounds were studied with oxidizing agents, reducing agents, etc.

GROUP REFERENCES

Group 1—150; **Group 2**—11, 13, 17, 19, 36, 46, 47, 52, 58, 59, 60, 66, 76, 92, 93, 104, 106, 108, 111, 112, 113, 114; **Group 3**—9, 21, 26, 37, 44, 45; **Group 4**—9, 24; **Group 5**—19, 59, 81, 82; **Group 6**—16, 34, 35; **Group 7**—3, 9, 14, 25; **Group 8**—6, 12, 13, 27, 29, 34, 37; **Group 10**—12, 18, 22, 23, 28, 29, 32, 34, 37, 40, 42, 46, 49, 56, 64, 65, 66, 74, 82, 83, 87, 89, 95, 96, 101, 105, 108, 110, 112, 113, 118, 121, 122, 124, 126, 135, 142, 143, 147, 148, 152, 154, 156, 162, 169, 172, 185, 188, 190, 193, 194, 199, 200, 202, 203, 206, 207, 208, 214, 218, 221, 225, 231, 233, 235, 236, 237, 239, 240, 241, 242, 249, 252, 255, 257, 258, 262, 264, 265, 266, 267, 270, 271, 272, 275, 280, 281, 284, 285, 286, 287, 288, 289, 290, 294, 295, 296, 298, 323, 324, 325, 326, 329, 330, 331, 339, 342, 343, 347, 353, 357, 359, 360, 364, 368, 371, 372, 376, 384, 389, 390, 391, 392, 393, 402, 407, 408, 409, 410, 412, 419, 424, 430, 434, 435, 436, 438, 439, 442; **Group 11**—3, 8, 22, 24, 32, 37, 42, 44, 45, 47.

GROUP 13

TRI AND POLYSULFIDES

1 Blanksma, J. J. *B.A.* 1901, i, 264. *Proc. K. Akad. Wetensch (Amsterdam)* 3, 457-9. Organic Polysulfides and the Polysulfides of Sodium. Have tetrasulfides of the type R-S-S-S-S R.

2 Blanksma, J. J. *B.A.* 1901, i, 462. *Rec. trav. chim.* 20, 144-5. Formation of Organic Tri- and Tetra-Sulfides. Boil orthodinitrobenzene with alcoholic sodium trisulfide replacing one of the nitro group with sulfur. Some of the product is also obtained by boiling the nitro compound with sodium disulfide plus 2 atoms of S.

3 Bloch, I., and Bergmann, M. *C.A.* 1920, 3414. *Ber.* 53B, 961-77. Hydrogen Persulfides. VI, Trisulfides and Tetrasulfides of Some Carboxylic Acids.*

4 Candiani, P. *B.A.* 1895, i, 585. *Gazz. chim. ital.* 25, i, 81-8. Ethenylic Trisulfide. Ethenylic trisulfide is prepared by the action of bromine vapor on thioacetic acid in a closed tube at ordinary temperature.

5 Fromm, E., and Klinger, M. *C.A.* 1913, 1002. *Ber.* 40, 2863. Tolane Tetrasulfide. The supposed tolane tetrasulfide, m. p. 164°, obtained by dry distillation of (BzS)₂ was shown to be tetraphenyl thiophene contaminated with sulfur.

6 Fromm, E., and Engler, L. *C.A.* 1926, 578. *Ber.* 58B, 1916-24. The Trithioacetaldehydes and the Mechanism of their Rearrangement.*

7 Fromm, E. *C.A.* 1928, 389. *Ber.* 60B, 2090-4. Cyclic Thioketones. Compounds of cyclopentanone, cyclohexanone, and p-methyl cyclohexone are given.

8 Hinsberg, O. *C.A.* 1913, 3498. *J. prakt. Chem.* 88, 49-58. Trimethylene Trisulfide and its Oxidation Products.*

9 Hinsberg, O. *C.A.* 1914, 3044. *J. prakt. Chem.* 89, 547-51. Trimethylene Trisulfide and its Oxides. The disulfone sulfoxide, mono-sulfone disulfide, isotrisulfoxide are given.

10 Hinsberg, O. *C.A.* 1924, 2900. *Ber.* 57B, 836-8. Trimethylene Trisulfides, II. A reply to Fromm and Soffner (see *C.A.* 1924, 1983).

11 Levi, G. R., and Baroni, A. *C.A.* 1929, 5158. *Atti. accad. Lincei* 9, 903-6. Diethyl Pentasulfides.*

12 Loven, J. M. *B.A.* 1893, i, 308. *J. prakt. Chem.* [2] 47, 173-82. Action of Hydrogen Sulfide on Pyruvic Acid. See *B.A.* 1884, 1298. H₂S on pyruvic acid forms trithiodilactic acid. Gives reactions and products formed with various reagents.

13 Ray, P. C. *C.A.* 1922, 3065. *J. Chem. Soc.* 121, 1279-83. Trimethylene Tri- and Tetra-sulfides, II. Action of Hg(NO₃)₂, EtI, HgI₂, HgCl₂ and PtCl₆ given.

14 Ray, P. C. *C.A.* 1924, 58. *J. Chem. Soc.* 123, 2174-8. Triethylene Tri- and Tetra-sulfides, III, The Sulfones, Sulfinic and Sulfonic Acids of the Series. Extension of Stuffer's Law. The action of the above sulfides with KMnO₄ and HNO₃ are given.

15 Ray, P. C. *C.A.* 1925, 2186. *Quart. J. Indian Chem. Soc.* 1, 207-12. The Oxidation of Triethylene Tetrasulfide By Means of Potassium Permanganate. Sulfones and sulfonic acids were obtained.

16 Schultz, G., and Beyschlag, H. *C.A.* 1909, 1267. *Ber.* 42, 753-7. Action of Sulfur on m-Tolylendiamine. The polysulfide described previously is formed from S and dithio-m-tolylene diamine, or m-diamino-m-thiocresol. Yield of polysulfide increases with amount of S present.

17 Strecker, W. *C.A.* 1908, 2220. *Ber.* 41, 1105-6. The Action of Dimethyl Sulfate on Alkali Polysulfides. Dimethyl sulfate and Na₂S₆ yield an oil which has the composition Me₂S₆; when distilled, it yields Me₂S₃.

18 Twiss, D. *C.A.* 1927, 890. *J. Am. Chem. Soc.* 49, 491-4. Aliphatic Poly-sulfides.*

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GROUP 14

SULFIDES

1 **Abel, J. J. B.A. 1895, ii, 81.** *Z. physiol. Chem.* **20**, 253-79. Ethyl Sulfide in Dog's Urine.
Found Et_2S . Gave compound with mercuric chloride, m. p. 119° ; oxidized with strong sulfuric acid yields acetic and sulfuric acid, not sulfone.

2 **Addy, C. W., and Macbeth, A. K. C.A. 1916, 2690.** *J. Chem. Soc.* **109**, 755-7. Trimethyl- and Triethyl-sulfonium Nitrates.
Methods of preparation and properties of these nitrates are given.

3 **Alvisi, U. B.A. 1897, i, 329.** *Z. anorg. Chem.* **14**, 302-8. Triethylsulfine Metaaluminate.
Formed by the action of triethylsulfine hydroxide on aluminum. Hydrogen is evolved, which reacts on unaltered free base to form ethyl sulfide, ethane and water, and aluminum hydroxide. When concentrated solution of the aluminate is heated, it is completely decomposed into ethyl sulfide, ethylene and aluminum hydroxide. Some decomposition occurs when solution is evaporated in *vacuo*. See abstract or original.

4 **Anschutz, R., and Biernaux, F. B.A. 1893, i, 191.** *Ann.* **273**, 64-73, see *B.A. 1891, 177.* Diglycollic and Thiodiglycollic Acid.
Thiodiglycollic chloride, anhydride, methyl ester, anilide, anilic acid, and parafollic acid have been prepared. M. p. given.

5 **Apitzsch, H. C.A. 1909, 441.** *Ber.* **41**, 4028-39. Action of Carbon Disulfide and Potassium Hydroxide on Ketones.
These react vigorously, forming sulfur derivatives.

6 **Apitzsch, H., and Bauer, G. A. C.A. 1909, 442.** *Ber.* **41**, 4039, 47. Thio- γ -pyronethiols.
In presence of light and various solvents β , β -diphenylthio- γ -pyrone-*a, a*, dithiol is transformed into a trimolecular sulfide. In *AcOH*, oxidizing agents produce the same compound from thiol.

7 **Armstrong, H. E. B.A. 1874, 803.** *Ber.* **7**, 407. Naphthyl Sulfides.
a- and β -naphthyl sulfides prepared by distilling a dry mixture of *K thiocyanate* and corresponding naphthyl sulfonate.

8 **Autenrieth, W. B.A. 1887, 463.** *Ber.* **20**, 373-6. Derivatives of Dimethylene Disulfone.
Gives details of preparation of duplo-sulfacetone. Yields methyl iodide addition product. Oxidizes to sulfone.

9 **Autenrieth, W. B.A. 1891, 204.** *Ann.* **259**, 365-73. Sulfur Derivatives of Ethyl Acetoacetate, Ethyl Methyl-acetoacetate and Ethyl Ethylacetacetate.
See abstract. Compare Bauman and Escales (*B.A. 1886, 878*).

10 **Autenrieth, W. B.A. 1891, 1067.** *Ber.* **24**, 1512-9. Certain Sulfone Derivatives and their Hydrolysis in Alkaline Solution.
Continuation of work of Stuffer (*B.A. 1891, 180*) and Autenrieth (*B.A. 1891, 567*). Gives method of oxidation of mercaptals to sulfones.

11 **Auwers, K., and Berger, C. B.A. 1894, i, 466.** *Ber.* **27**, 1733-41. Application of Friedel and Craft's Reaction to Thiophenol Ether.
Thiophenol ether in carbon disulfide with benzoyl chloride and aluminum trichloride forms thiobenzophenone. Other condensation products also reported.

12 **Auwers, K., and Baum, F. B.A. 1897, i, 34.** *Ber.* **29**, 2329-48. Constitution of Dibromopseudocumenol Bromide and of its Derivatives.
Tribromoderivatives of Ψ -cumenol when shaken with aqueous solution of sodium sulfide yields a sulfide. On oxidation with dilute nitric acid decomposes.

13 **Auwers, K., and Arndt, F. C.A. 1909, 1025.** *Ber.* **42**, 537-45. Method of Preparation of Hydroxythionaphthenes.
By action of AcCl and AlCl_3 on p-thiocresyl methyl ether. Colorless needles, m. p. 102. Certain derivatives given.

14 **Auwers, K., and Arndt, F. C.A. 1909, 2577.** *Ber.* **42**, 2713-5. Addition of Dimethyl Sulfate to Thiophenyl Ethers.
Sulfonium compounds are prepared.

15 **Bales, S. H., and Nickelson, S. A. C.A. 1923, 61.** *J. Chem. Soc.* **121**, 2137-9. Hydrolysis of β , β' -Dichlorodiethyl Sulfide. Synthesis of Divinyl Sulfide and the Preparation of a Non-vesicant Isomeride of β , β' -Dichloroethyl Sulfide.*

16 **Bales, S. H., and Nickelson, S. A. C.A. 1924, 51.** *J. Chem. Soc.* **123**, 2486-9. Hydrolysis of β , β' -Dichlorodiethyl Sulfide and Action of Hydrogen Halides on Divinyl Sulfide.*

17 **Baumann, E. B.A. 1887, 123.** *Ber.* **19**, 2806-14. Disulfones.
Prepared several disulfones. Stable. Soluble in sulfuric acid and decompose when warmed.

18 **Baumann, E., and Fromm, E. B.A. 1890, 26.** *Ber.* **22**, 2592-9. Thio derivatives of Ketones.
Thioacetone has a very unpleasant odor. It is formed along with trithioacetone, but in small quantities. Acetone ethyl mercaptone on heating above 160° gives ethyl sulfide and some of the thioacetone. Trithioacetone oxidizes with explosive violence with nitric acid. With permanganate forms trisulfone.

19 **Bell, E. V., Bennett, G. M., and Hock, A. L.** *C. A.* 1927, 3599. *J. Chem. Soc.* 1927, 1803-9. Decomposition of Some Halogenated Sulfides and the Nature of the "Polymeric" Ethylene Sulfides.*

20 **Bennett, G. M.** *C. A.* 1927, 223. *Nature* 118, 555. Lengthened Chain Compounds of Sulfur. Polemic against Ray and Bose-Ray (*C. A.* 1926, 3687).

21 **Bennett, G. M., and Hock, A. L.** *C. A.* 1928, 381. *J. Chem. Soc.* 1927, 2496-9. Nature of the Supposed Dimethiodide of Trimethylene Sulfide.*

22 **Blanksma, J. J.** *B. A.* 1902, i, 209. *Proc. K. Acad. Wetensch. (Amsterdam)* 4, 264-6. Influence of Different Atoms and Atomic Groups on the Conversion of Aromatic Sulfides into Sulfones. The steric influence of groups in the ortho-position in aromatic sulfides on the conversion of the latter into sulfones by means of nitric acid, sp. gr. 1.52, was investigated.

23 **Blattler, H.** *C. A.* 1920, 1810. *Momnath.* 40, 417-29. Trimethylsulfonium Compounds. Compounds of Cu, Zn, Cd, Mn, Fe, Sn and Bi given.

24 **Blomstrand, C. W.** *B. A.* 1889, 230. *J. prakt. Chem.* [2] 38, 352-8. Platinum Compounds of Ethyl Sulfide.*

25 **Boeseken, J.** *C. A.* 1911, 678. *Rec. trav. chim.* 29, 315-29. Action of Bromine on Diphenylsulfide, Diphenylsulfoxide, and Diphenylsulfone. Ph_2S and Br in AcOH (Bourgeois, *Ber.* 28, 2321) give $(\text{p-BrC}_6\text{H}_4)_2\text{S}$, $\text{p-C}_6\text{H}_4\text{SPh}$ and Ph_2S . Ph_2SO and Br in AcOH give $(\text{p-BrC}_6\text{H}_4)_2\text{S}$. Ph_2SO in glacial AcOH and dry Cl react in sunlight giving Ph_2SO_2 , PhCl , PhSO_2Cl , H_2SO_4 , and SO_2 . Ph_2S with glacial AcOH gives $(\text{p-C}_6\text{H}_4)_2\text{S}$; with AcOH containing 10% water gives Ph_2SO_2 . On water bath Ph_2SO_2 and Br in AcOH do not react. Heated at 200° in sealed tube 6 hours it gives Ph_2SO_2 , PhBr , 1,4- $\text{C}_6\text{H}_4\text{Br}_2$ and possibly $\text{C}_6\text{H}_2\text{Br}_4$ and H_2SO_4 .

26 **Bottinger, C.** *B. A.* 1880, 238. *Ber.* 12, 1425-6. New Method of Preparing Thiodilactic Acid. See *Ann.* 188 and 196. Prepared by treating pyroacemic acid in strongly alkaline solution with H_2S for a long time.

27 **Boulin, C., and Simon, L. J.** *C. A.* 1920, 2165. *Compt. rend.* 170, 845-8. Action of Water on Dichlorodimethyl Sulfide. $\text{S}(\text{C}_2\text{H}_4\text{OH})_2$ was obtained in 95% to 100% yield by hydrolyzing $\text{S}(\text{C}_2\text{H}_4\text{Cl})_2$ with boiling water.

28 **Brand, K.** *C. A.* 1910, 316. *Ber.* 42, 3988. o-Nitrothioanisole. Correction. o-Nitrothioanisole melts at 64°-65°, not 83°-87°.

29 **Brand, K., and Grobel, P.** *C. A.* 1924, 1655. *Ber.* 56B, 2563-7. Thio-phenols. V. Salts and Addition Compounds of o, o'-Azophenyl Methyl Sulfide. Perchlorate, sulfate, hydrochloride given. Also FeCl_3 salt, sulfonium iodide and various other derivatives given.

30 **Brand, K., and Stallmann, O.** *C. A.* 1924, 2513. *J. prakt. Chem.* 107, 358-82. Thiophenols. VI. Thiophenol Ethers of Triphenylmethane and the Auxochromic Action of the Alkymercapto Groups.*

31 **Brand, K., and Stein, H.** *C. A.* 1924, 3181. *J. prakt. Chem.* 108, 19-28. Thiophenols. IX. o-Ethyl Mercapto-triphenyl-carbinol.*

32 **Braun, E.** *B. A.* 1888, 243. *Ber.* 20, 2967-70. Sulfuranes. Ethyl sulfurane $\text{EtS} \cdot \text{C}_2\text{H}_4 \cdot \text{S} \cdot \text{C}_2\text{H}_5$ heated for many hours with excess ethyl iodide at 100°, a sulfine iodide is formed (not identified) and ethylene disulfide. Diethyl derivative of ethylene mercaptan when treated with ethyl iodide in like manner is converted into triethyl sulfine iodide and ethylene disulfide.

33 **Braun, J. v., and Engelbertz, P.** *C. A.* 1924, 66. *Ber.* 56B, 1573-7. Mixed Organic Sulfides and Cyanogen Bromide. As in the case of mixed tertiary amines, so MeSEt , EtSPr and PrSBu with BrCN split off the lighter group Me, Et, and Pr. There is almost a complete parallelism between S and N as regards the firmness with which individual org. residues are attached to them.

34 **Bruyn, C. A. de, and Blanksma, J. J.** *B. A.* 1901, i, 460. *Rec. trav. chim.* 20, 115-20. Aromatic Nitro-compounds. XVI, Comparative Study of the Three Dinitrobenzenes. III, Action of the Sodium Monosulfide. o-Dinitrobenzene boiled with alcoholic solution of sodium sulfide forms disulfide which can be oxidized to sulfoxide, then sulfone. Different results with meta and para.

35 **Bunzly, H., and Decker, H.** *B. A.* 1904, i, 912. *Ber.* 37, 2931-8. Xanthonium and Thioxanthonium Compounds. See abstract for preparation and salts formed.

36 **Cahours, A.** *B. A.* 1873, 365. *Compt. rend.* 126, 133. New Propyl Derivatives. Prepared propyl sulfide from K_2S and propyl Br or I in alcohol. Propyl sulfide and propyl iodide and trace of water in sealed tube form sulfonium iodide and PtCl_4 derivative formed. Propyl iodide and ethyl sulfide or methyl react to form sulfonium compounds.

37 **Cahours, A.** *B. A.* 1875, 1181. *Compt. rend.* 130, 1317-23. Researches on the Sulfines. Heated benzyl bromide and methyl sulfide at 100° for a few seconds and got trimethyl sulfonium bromide and methyl benzyl sulfide. If methyl alcohol is present got methyl benzyl ether instead of sulfide. Heated dibenzyl sulfide at 100° for 7 to 8

hours with methyl iodide and got trimethyl sulfonium iodide and benzyl iodide. Methylene iodide and ethylene bromide gave similar results.

38 **Carlier, E. W., and Evans, C. L.** *C. A.* **1907**, 2385. *Biochem. J.* **2**, 325-39. Allyl Sulfide: Some Aspects of the Physiological Action with an Analysis of the Common Leek. Allyl sulfide acts chiefly on the respiratory center in the medulla, paralyzing it when large doses are given intravenously.

39 **Carrara, G. B. A.** **1892**, 1422. *Gazz. chim. ital.* **22**, 408-15. New Method of Preparing Dimethylethylsulfine and Methylethyl Sulfide. Heat methyl sulfide in sealed tube with iodine at 110°-120° for 24 hours.

40 **Carrara, G. B. A.** **1895**, ii, 8. *Gazz. chim. ital.* **24**, ii, 68-75. Velocity of Reaction between Alkyl Sulfides and Alkyl Iodides. Discusses reaction between methyl sulfide and ethyl iodide, and methylethyl sulfide and methyl iodide to form same compounds. Studies different valencies of sulfur but has not shown that there is any difference.

41 **Carrara, G., and Ferrari, G. B. A.** **1906**, ii, 599. *Gazz. chim. ital.* **36**, i, 419-29. Magnitude of the Liquid Molecules of Certain Organic Compounds. Thiophene and ethyl sulfide studied.

42 **Cashmore, A. E. C. A.** **1923**, 3157. *J. Chem. Soc.* **123**, 1738-45. Hydrolysis of the Sulfoxide and the Sulfone of β, β' -Dichlorodiethyl Sulfide. None of the derivatives has a vesicant action, and they are of little physiol. importance.

43 **Cashmore, A. E., and McCombie, H. C. A.** **1924**, 376. *J. Chem. Soc.* **123**, 2884-90. Interaction of β, β' -Dichlorodiethyl Sulfide, Sulfoxide and Sulfone with Glycine Ester and with Potassium Phthalimide.* The results of the study are expressed graphically.

44 **Chaumeil, and Thomas, V. C. A.** **1923**, 2417. *Compt. rend.* **176**, 1323-5. Picryl Sulfide; The Binary System Tri-nitroanisole-picryl Sulfide. The article is a summary of observations made on mustard gas as to: a. preparation; b. excess of S in products; c. possible occurrence of isomers in the industrial products; d. cryoscopic constant of the substance.

45 **Chelintzev, V. V. C. A.** **1913**, 1175. *J. Russ. Phys. Chem. Soc.* **44**, 1885-94. Thionic Dibromides of Sulfides. R_2SBr_2 resemble in appearance and general behavior the R_2OBBr_2 . The differences are given by author.

46 **Chrzaszczewska, A., and Chwalinski, S. C. A.** **1929**, 1629. *Roczniki Chem.* **8**, 432-43. Derivatives of Phenacyl Sulfide.*

47 **Chugaev, Z., and Fraenkel, D. C. A.** **1912**, 860. *Compt. rend.* **154**, 33-5. Complex Compounds of Platinum Bromide and Organic Sulfides. The various complex compounds are described.

48 **Chugaev, L., and Benevolenskii, I. C. A.** **1913**, 3936. *Z. anorg. Chem.* **82**, 420-5. Complex Compounds of Organic Sulfides with Tetravalent Platinum.*

49 **Coffey, S. C. A.** **1921**, 1280. *J. Chem. Soc.* **119**, 94-8. The Action of the Chlorides of Sulfur on Substituted Ethylenes. The Action of Propylene on Sulfur Monochloride and the Synthesis of β, β' -Dichlorodipropyl Sulfide. Preparation and properties given.

50 **Courtot, C., and Pomonis, C. C. A.** **1926**, 2155. *Compt. rend.* **182**, 931-2. Diphenylene Sulfide.*

51 **Courtot, C., Nicholas, L., and Liang, T. H. C. A.** **1928**, 3152. *Compt. rend.* **186**, 1624-6. Diphenylene Sulfide. Various derivatives and their properties given.

52 **Crum-Brown, W., and Letts, E. A. B. A.** **1874**, 980. *Ber.* **7**, 695. An Addition Product of Bromacetic Acid and Methyl Sulfide. Methyl sulfide or ethyl sulfide condenses with bromacetic acid forming sulfonium compound.

53 **Crum-Brown, A., and Blaikie, J. A. B. A.** **1882**, 592. *Proc. Roy. Soc. Edinburgh* **10**, 53-5, and 253. Action of Heat on the Salts of Trimethyl Sulfine. The trimethyl sulfine acetate when heated is decomposed into water, methyl sulfide, and methyl acetate. Benzoate, carbonate, and metaphosphate also studied.

54 **Davies, W. C. A.** **1920**, 1968. *J. Chem. Soc.* **117**, 297-308. Synthetic Experiments with β, β' -Dichloroethyl Sulfide.*

55 **Delepine, M., and Jaffeux, P. C. A.** **1921**, 1283. *Compt. rend.* **172**, 158-60. The Two Homologs of Ethylene Sulfide; 1,2-Thiopropane and 1,2-Thiobutane. Method of preparation given. Colorless liquids, mobile, strong peculiar odor, insoluble in water, very volatile. Not as reactive as ethylene sulfide.

56 **Delepine, Fleury, and Ville. C. A.** **1921**, 2881. *Compt. rend.* **172**, 1238-40. β, β' -Dichloroethyl Sulfide. The article is a summary of observations made on mustard gas as to: a. preparation; b. excess of S in products; c. possible occurrence of isomers in the industrial products; d. cryoscopic constant of the substance.

57 **Desgrez, A., Guillemand, H., and Labat, A. C. A.** **1922**, 977. *Chemie und Industrie* **6**, 842-4. Protection Against Bis (β -Chloroethyl) Sulfide. The main properties of mustard gas are given and protective measures in buildings, water, garments, skin and metallic objects.

58 **Dilthey, W. C. A.** **1927**, 2885. *Ber.* **60B**, 1403-5. Reactivity of Positivized Hydrogen Atoms. I, Diphenacyl Sulfides.*

59 **Ditte, A.** *C. A.* 1908, 237. *Ann. chim. phys.* **12**, 229-76. Researches on the Simple and Double Sulfides.
An exhaustive study of the behavior of certain metallic sulfides in presence of alkaline sulfides.

60 **Enebuske, C.** *B. A.* 1889, 229. *J. prakt. Chem.* [2] **38**, 358-65. Platinum Compounds of Methyl Sulfide.*

61 **Escales, R., and Baumann, E.** *B. A.* 1887, 123. *Ber.* **19**, 2814-7. Disulfones. Prepared ethylenedithiolsulfone and brom derivative, also the diphenyl homolog.

62 **Faragher, W. F., Morrell, J. C., and Comay, S.** *C. A.* 1929, 4925. *J. Am. Chem. Soc.* **51**, 2774-81. Interaction of Alkyl Sulfides and Salts of Mercury. The mechanism of the reaction between Hg salts and alkyl sulfides is given, also physical constants.

63 **Farbwerke vorm. Meister Lucius, and Brüning.** *B. A.* 1904, i, 313. *D. R. P.* **147,634**. Preparation of Hydroxydialyl Sulfides.
Heat arylsulfonic acids with phenols or phenol derivatives at 100°-150°.

64 **Felsing, W. A., Odeen, H., and Peterson, C. B.** *C. A.* 1921, 54. *J. Ind. Eng. Chem.* **12**, 1063-5. Decomposition of and Pressure Developed by Mustard Gas in Steel Shell at 60°C.*

65 **Felsing, W. A., and Arenson, S. B.** *C. A.* 1921, 54. *J. Ind. Eng. Chem.* **12**, 1065-6. The Precipitation of Sulfur from Crude Mustard Gas by Means of Ammonia.*

66 **Fichter, F., and Sjostedt, P.** *C. A.* 1911, 894. *Ber.* **43**, 3422-9. Electrolytic Oxidation of Aromatic Sulfides. Benzyl sulfide was oxidized to the sulfone, disulfoxide, and sulfone, conditions being given. Tribenzylsulfonium sulfate was also formed and its properties given.

67 **Finzi, C.** *C. A.* 1928, 2151. *Atti. II congresso naz. chim. pura applicata* 1926, 1312-5. Thiophenols. Formation of Heterocyclic Sulfurated Nuclei. Methods of formation and properties given.

68 **Fischer, E.** *C. A.* 1909, 1752. *Ber.* **42**, 1070-1. Acetylal Sulfide. Chloracetal and aqueous K₂S or KSH give the acetal sulfide. Soluble in water, precipitated by NaCl, and decomposed by boiling water, 1% HCl.

69 **Fischer, O., and Fischer, G.** *B. A.* 1895, i, 343. *1895*, i, 457. *Ber.* **28**, 879-81; 1337-41. Paradiamidobenzyl Sulfide. Alcoholic ammonium sulfide on parabenzyl chloride gives the sulfide. Reduced with stannous chloride and hydrochloric acid to paramidophenyl sulfide.

70 **Forster, A., Cooper, C., and Yarrow, G.** *C. A.* 1917, 3244. *J. Chem. Soc.* **111**, 809-14. Compounds of Ferric Chloride with Ether and with Dibenzyl Sulfide.*

71 **Fosse, R.** *C. A.* 1913, 768. *Compt. rend.* **155**, 1019-20. Transformation of an Alcohol to a Sulfide or a Peroxide by Means of Hydrogen Sulfide or Hydrogen Peroxide. $O(C_6H_5)_2\text{CHOH}$ dissolved in AcOH and treated with H₂S gives xanthylsulfide. Under similar conditions H₂O₂ yields xanthyl peroxide.

72 **Fries, K., and Vogt, W.** *C. A.* 1911, 3443. *Ann.* **381**, 337-46. Chlorides and Bromides of Diphenyl Sulfide.
At 0°, dry Cl and Ph₂S in C₆H₆ give very unstable dichloro additive compound. Gradually evolves HCl and decomposes into mixture of mono- and dichloro-diphenyl and diphenyl sulfides. In presence of water, the additive compound forms HCl and diphenyl sulfoxide. Diphenyl thiodibromide is prepared in hexane at temperature of salt and ice. Alone or with water it passes into mixture of diphenyl sulfide and its mono-and dibromo-substitution products.

73 **Fritzmann, E. C.** *C. A.* 1928, 1110. *Ann. inst. platiné* **1926**, No. 4, 55-179. The Complex Compounds of Platinum and Palladium with Organic Sulfides.*

74 **Fromm, E., and Raiziss, G.** *C. A.* 1910, 2307. *Ann.* **374**, 90-105. Basic Properties of Sulfoxides and their Tautomerism.
Authors show that sulfides and sulfones with bitertiary S and SO groups do not react with Br or hydrohalic acids, whereas those containing primary S and SO groups do. Data for substances with secondary S and SO groups not available. Reactions best explained by assuming tautomeric forms, the enol being basic.

75 **Fromm, E., and Flaschen, J.** *C. A.* 1913, 1000. *Ann.* **394**, 310-24. Stereoisomerism of Phenacyl Sulfide Derivatives.*

76 **Fromm, E., and Ehrhardt, A.** *C. A.* 1921, 2075. *Ber.* **54B**, 187-93. Stereoisomeric Derivatives of Phenacyl Sulfide.
Hydrazone derivatives were prepared by boiling the sulfide with hydrazine hydrate.

77 **Gattermann, L.** *B. A.* 1899, i, 513. *Ber.* **32**, 1127-35. Thiofluorescein and Some Derivatives of the Phthaleins. Gives preparation.

78 **Gazdar, M., and Smiles, S.** *C. A.* 1909, 886. *J. Chem. Soc.* **93**, 1833-6. The Interaction of Hydrogen Peroxide and Sulfites.
H₂O₂ in aqueous or acetone solutions converts sensitive sulfides almost quantitatively into sulfoxides. Reaction applied to various ones.

79 **Gazdar, M., and Smiles, S.** *C. A.* 1911, 1082. *J. Chem. Soc.* **97**, 2248-53. Aromatic Hydroxysulfoxides.
BzCl in alc. solution converts p-cresol-m-sulfoxide into benzoyl deriv. Zn dust in

glacial AcOH converts sulfoxide into di-p-cresol sulfide. Nitro-p-cresol sulfoxide and sulfide are given. SOCl on p-chlorophenol gives the sulfoxide. p-Chloronitrophenyl sulfoxide and sulfide given.

80 **Gibson, C. S., and Pope, W. J. C.A. 1920, 1967.** *J. Chem. Soc.* **117**, 271-8. β, β' -Dichloroethyl Sulfide. A method of preparation and its reaction with concentrated HNO_3 and Br given.

81 **Gilman, H., Smith, L. E., and Parker, H. H. C.A. 1925, 1256.** *J. Am. Chem. Soc.* **47**, 851-60. Constitution of Disulfoxides.*

82 **Gilman, H., and Vernon, C. C. C.A. 1929, 4460.** *Rec. trav. chim.* **48**, 745-7. The Reaction Between Phenylmagnesium Bromide and Some Amides of Sulfonic, Sulfinic and Sulfenic Acids.*

83 **Giua, M. C.A. 1925, 1561.** *Atti. congresso naz. chim. ind.* **1924**, 370-3. Industrial Preparation of Picryl Sulfide.*

84 **Giua, M., and Franciscis, V. C.A. 1925, 2483.** *Ann. chim. applicata* **15**, 137-45. New Method for the Industrial Preparation of Picryl Sulfide. See article.

85 **Goldberg, M. C.A. 1919, 2369.** *J. Am. Chem. Soc.* **41**, 1414-31. Ethylenechlorohydrin and β, β' -Dichloroethyl Sulfide.*

86 **Grabowsky, N. B.A. 1875, 628.** *Ann. 175*, 348-51. Action of Nitric Acid on Normal Butyl Sulfide. Researches of Oefele (*Ann.* **127**, 370 and **132**, 86) and Saytzeff (*Ann.* **139**, 354 and **144**, 148) showed that thio ethers with normal radicals yield both oxides and sulfones while others yield oxides only. Studied oxidation of butyl sulfide to oxide and sulfone with nitric acid. Gives methods of purification. Both oxide and sulfone can be reduced.

87 **Graebe, C. B.A. 1874, 469.** *Ber.* **7**, 50-2. Diphenylene Sulfide and Disulfide. Historical. Compares previous researches.

88 **Graebe, C. B.A. 1875, 454.** *Ber.* **7**, 1629-30. On the Difference Between the Boiling Points of Diphenyl and Diphenylene Compounds. Diphenylene compounds boil 40°-41° higher than the corresponding diphenyl compound.

89 **Green, A. G. C.A. 1920, 174.** *J. Soc. Chem. Ind.* **39**, 363-4R. History of Mustard Gas.*

90 **Green, A. G. C.A. 1920, 944.** *J. Soc. Chem. Ind.* **38**, 469R. History of Mustard Gas.*

91 **Guareschi, L. B.A. 1884, 294.** *Gazz. chim. ital.* **13**, 500. Thioaldehyde and Carbovaleraldine. Thioaldehyde oxidized with potassium permanganate yields sulfuric acid, acetic acid, and ethylidene sulfuric acids. Zinc permanganate gave more oxysulfides.

92 **Henry, L. B.A. 1887, 24.** *Compt. rend.* **103**, 603-6. Volatility of Methane Derivatives. Compared boiling point of methyl sulfide with other methyl compounds.

93 **Hepworth, H., and Clapham, H. W. C.A. 1921, 3088.** *J. Chem. Soc.* **119**, 1188-98. Action of Grignard Reagent on Certain Organo-sulfur Compounds. PhSO_2Cl and EtSO_2Cl give sulfoxides, while sulfides and sometimes sulfones to a smaller extent.

94 **Hermann, F. C.A. 1907, 427.** *Ber.* **39**, 3812-6. Disruptive Action of Hydrogen Chloride. See abstract for effect on compounds such as aurodibenzylsulfine chloride.

95 **Hilditch, T. P., and Smiles, S. C.A. 1911, 3053.** *J. Chem. Soc.* **99**, 973-84. Constitution of Dihydro- β -Naphthol Sulfide and the Interaction of Sulfuric Acid with Aromatic o-Hydroxy Sulfones. When the sulfoxides were triturated with cold concentrated sulfuric acid and poured into ice water, thio-oxonium compounds result.

96 **Hinsberg, O. B.A. 1903, i, 251.** *Ber.* **36**, 107-15. Action of Benzenesulfinic Acid on Phenols and Aromatic Amines. Benzenesulfinic acid combines with phenols to form sulfides or sulfones, and with amines to form sulfides or sulfoxides.

97 **Hinsberg, O. C.A. 1908, 3361.** *Ber.* **41**, 2836-9. Preparation and Constitution of Sulfoxides and Disulfoxides. Dibenzoylsulfoxide from H_2O_2 and dibenzylsulfide in glacial AcOH. Diphenyldisulfide and dibenzylidisulfide were prepared similarly.

98 **Hinsberg, O. C.A. 1910, 1162.** *Ber.* **43**, 289-90. Behavior of Phenyl Sulfide Towards Hydrogen Peroxide. Obtain almost quantitative yield of sulfide when 1 mol. H_2O_2 in glacial AcOH acts on sulfide at ordinary temperature 4 days. With 2.5 mol. H_2O_2 under similar conditions product consists chiefly of sulfone.

99 **Hinsberg, O. C.A. 1915, 209.** *J. prakt. Chem.* **90**, 345-53. β -Naphthol Sulfide and Iso- β -Naphthol Sulfide. A study of the nature of the isomerism of β -naphthol sulfide given.

100 **Hinsberg, O. C.A. 1924, 254.** *Ber.* **56B**, 1735-6. The Isomerism of β -Naphthol Sulfide and its Derivatives.*

101 **Hinsberg, O. C.A. 1929, 2703.** *Ber.* **62B**, 127-35. Isophenyl Sulfide and Its Derivatives. Its preparation and properties given.

102 **Hjelt, E. B.A. 1890, 134.** *Ber.* **22**, 2904-5. Xylylene Sulfides. Unstable. Prepared by method of Leser (B.A. 1884, 1313).

103 **Hodgson, H. H., and Handley, F. W. C.A. 1928, 1965.** *J. Chem. Soc.* **1928**, 625-8. Sulfur Derivatives of Aromatic Methyl Ethers.*

104 Hofmann, K. A., and Ott, K. C.A. 1908, 816. Ber. 40, 4930-6. Sulfoxides and Sulfines.
Toluene, thionyl chloride and FeCl_3 yield the compound $(\text{MeC}_6\text{H}_4)_2\text{SOFeCl}_3$. Warm water converts it into tolyl sulfoxide and FeCl_3 . Similar compounds formed from FeCl_3 and benzylsulfoxide or phenylsulfoxide and thionylchloride. The ferrocyanides and iodides are also given.

105 Holmberg, B. C.A. 1907, 2233. Ann. 353, 131-8. On Methinetrithioglycollic Acid.
On oxidation with Br_2 sulfoacetic is formed. Hydrolyzed by hot alkali or hot concentrated HCl. Preparation given.

106 Kaufmann, L. C.A. 1908, 3357. Ber. 41, 2762-6. Triphenylstibine Sulfide.
Compound prepared by action of H_2S on triphenylstibine bromide in alcoholic NH_3 . Colorless needles, m. p. 119°-120°.

107 Klason, P. B.A. 1895, i, 488. Ber. 28, 1493-1500. Platinum Compounds of Ethylic Sulfides.*

108 Klinger, H., and Massen, A. B.A. 1888, 357. Ann. 243, 193-218. Sulfines and the Valency of Sulfur.
Prepared platino-, auro-, mercurio-chlorides and cadmo-iodide of diethylmethylsulfine iodide. See Kruger (B.A. 1877, i, 186).

109 Krafft, F. B.A. 1875, 153. Ber. 7, 1164-5. Thiobenzene and Thioaniline.
Prepared derivatives of diphenylsulfide by substitution in the aromatic nucleus. Sulfonic acid derivative formed.

110 Krafft, F. B.A. 1890, 1311. Ber. 23, 2364-9. Dinaphthyl Sulfides and Dinaphthyl Sulfones.
Sulfone obtained by oxidizing the sulfide with sulfuric acid and potassium dichromate. Sulfoxide also prepared. Directions for oxidations given in abstracts.

111 Kruber, O. C.A. 1921, 90. Ber. 53B, 1566-7. Biphenylene Sulfide in Coal Tar.
Obtained from the crude phenanthrene. Sulfone also given.

112 Kruger, F. B.A. 1877, i, 186-8. J. prakt. Chem. [2] 14, 193-213. Isomeric Sulfine Compounds.
Prepared diethyl-, methyl-, and ethyl-methyl-sulphine. Studied double compounds of HgCl_2 , AuCl_3 , etc.

113 Lange, N. A., and Haupt, H. S. C.A. 1929, 3924. J. Am. Chem. Soc. 51, 2277-8. β, β' -Dinaphthyl Sulfide as a By-product in the Preparation of β -Naphthonitrile. Reduction of the Sulfone with Sodium Cyanide.*

114 Larsson, E. C.A. 1928, 4470. Ber. 61B, 1439-43. Electrolytic Reduction of Dithiodiglycollic Acid.
Procedure given for the preparation.

115 Laves, E. B.A. 1890, 988. Ber. 23, 1414-7. Oxidation of Phenyl Trithioformate.

116 Laves, E. B.A. 1892, 153. Arch. Pharm. 229, 448-56. Chemical and Physiological Relations of Sulfones; Tri-Sulfones.
Prepared ethyl trithioacetate and then sulfone.

117 Laves, E. B.A. 1892, 611. Ber. 25, 347-60. Trithioorthoformates.
The trisulfone, $\text{CH}(\text{SO}_2\text{Ph})_3$, forms sodium or potassium salt. Hydrogen also replaced by chlorine or bromine. Other sulfones also studied.

118 Laves, E. B.A. 1892, 613. Ber. 25, 361-6. Formation of Trisulfones from Disulfones.
Attempts to form tetrasulfone were negative. See correction in Ber. 25, 1070-1 (B.A. 1892, 850).

119 Lawson, W. E., and Reid, E. E. C.A. 1926, 39. J. Am. Chem. Soc. 47, 2821-36. Reactions of β, β' -Dichloroethyl Sulfide with Amino Compounds.
Various thiazones were obtained by action of the above sulfide on certain NH_2 compounds.

120 Lawson, W. E., and Dawson, T. P. C.A. 1928, 381. J. Am. Chem. Soc. 49, 3119-25. Chlorination of β, β' -Dichloroethyl Sulfide.
The sulfonium chloride is formed which decomposes at room temperature to give HCl and α, β, β' -trichloroethyl sulfide. The sulfoxide is also given. Other sulfides studied also.

121 Lecher, H., and Holschneider, F. C.A. 1924, 2877. Ber. 57B, 755-8. Phenylsulfur Chloride.
By action of Cl on cold solution of PhSH in CCl_4 . Red liquid fuming in air, smells very much like SCl_2 .

122 Lesser, R., and Gad, G. C.A. 1923, 3181. Ber. 56B, 963-78. The Isomerism of β -Naphthol Sulfide and Analogous Isomerisms of Aromatic o-Hydroxysulfides.*

123 Lesser, R., and Gad, G. C.A. 1924, 254. Ber. 56B, 1802. Remark on our Communication: "The Isomerism of β -Naphthol Sulfide and Analogous Isomerisms of Aromatic o-Hydroxysulfides."*

124 Lewin, L. N. C.A. 1928, 1950. J. prakt. Chem. 118, 282-6. Oxidation of Sulfides by Benzoyl-hydroperoxide.
Sulfides are quantitatively oxidized to sulfones.

125 Lewin, L. N. C.A. 1928, 3400. J. prakt. Chem. 119, 211-4. Oxidation of Sulfides by Benzoyl-hydroperoxide.
With calc. amount of the hydroperoxide various sulfides give quant. the sulfoxides. With an excess of the reagent the sulfones are formed.

126 Limprecht, H. B.A. 1873, 1032. Ber. 6, 534. On a Compound, $\text{C}_4\text{H}_8\text{S}_2$.

Monochlorbenzyl sulfide on dry distillation forms a new compound which was not identified, though many of its properties are given.

127 Londahl, H. *B. A.* 1889, 368. *J. prakt. Chem.* [2] 38, 512-23. Platinum Compounds of Butyl, Isobutyl, and Benzyl Sulfides.*

128 Loven, J. M. *B. A.* 1885, 241. *Ber.* 17, 2817-25. Some New Sulfo-derivatives of the Fatty Acids. Prepared thioglycolic acid and salts. Oxidized to sulfone. Beginning with sulfone formed higher acids by reaction of alkyl halide with the sodium compound $\text{SO}_2(\text{CHNaCOOEt})_2$.

129 Loven, J. M. *B. A.* 1886, 241. *Ber.* 18, 3242-5. Perkin's Reaction. Synthesis of a Sulfur Derivative of Cinnamic Acid. Thioglycolic acid with benzaldehyde and acetic anhydride forms a substituted acid, $\text{COOH}-\text{C}(\text{CHPh})-\text{S}-\text{C}(\text{CHPh})\text{COOH}$. Sodium salt and bromine derivative mentioned.

130 Loven, J. M. *B. A.* 1886, 332. *J. prakt. Chem.* [2] 33, 101-15. Thio-derivatives of Butyric, Isobutyric, and Isovaleric Acids. Compare Loven (*B. A.* 1885, 241). Prepared from the brom derivative of the ethyl ester and potassium sulfide in alcohol. Prepared one sulfone from diisovaleric acid by use of ethyl sulfone diacetate, sodium ethoxide, and isopropyl iodide.

131 Loven, J. M. *B. A.* 1894, i, 325. *Z. physik. Chem.* 13, 550-60. Affinity Constants of Some Sulfur Compounds. Using Kohlrausch's method determined affinity constants at 25°. Increase in strength of acid by oxidation of S to SO_2 very marked. $\text{S}(\text{CH}_2\text{COOH})_2$, 0.049; $\text{S}(\text{CHMeCOOH})_2$, m. p. 125°, 0.049; m. p. 109°, 0.044; $\text{S}(\text{CH}_2\text{CH}_2\text{COOH})_2$, 0.0078; $\text{COOCH}_2\text{SCHMeCOOH}$, 0.048; $\text{COOCH}_2\text{SCH}_2\text{CH}_2\text{COOH}$, 0.025; $\text{COOCH}_2\text{SCHMeCOOH}$, 0.021; $\text{S}_2(\text{CHMeCOOH})_2$, 0.090; $\text{S}_2(\text{CH}_2\text{CH}_2\text{COOH})_2$, 0.0090; $\text{S}_2(\text{CHMeCOOH})_2$, 0.080; $\text{SO}_2(\text{CH}_2\text{COOH})_2$, 1.30; $\text{SO}_2(\text{CHMeCOOH})_2$, 1.03; $\text{SO}_2(\text{CH}_2\text{CH}_2\text{COOH})_2$, 0.024; $\text{COOCH}_2\text{SO}_2\text{CH}_2\text{CH}_2\text{COOH}$, 0.51.

132 Loven, J. M. *B. A.* 1896, i, 412. *Ber.* 29, 1132-6. Stereoisomeric Thiodilactic Acids. Studied separation.

133 Loven, J. M. *B. A.* 1896, i, 412. *Ber.* 29, 1136-9. Thiodihydracrylic Acid and β -Sulfonedipropionic Acid.*

134 Loven, J. M. *B. A.* 1896, i, 412. *Ber.* 29, 1139-43. Unsymmetrical Homologs of Thioglycolic Acid and of Sulfonediacetic Acid. Oxidized acids to sulfones by means of 2% potassium permanganate.

135 Mabery, C. F., and Smith, A. W. *B. A.* 1890, 350. *Ber.* 22, 3303-5. Sulfur Compounds in Raw Petroleum and in Petroleum Residues. Identified methyl, propyl, and butyl sulfides.

136 Mabery, C. F., and Smith, A. W. *B. A.* 1891, 1172. *Am. Chem. J.* 13, 233-43. Sulfur Compounds in Ohio Petroleum. See also *B. A.* 1890, 350. Isolated alkyl sulfides from the sludge acids. Small quantities of sulfur compounds were obtained directly from crude petroleum.

137 Mabery, C. F., and Quayle, W. O. *B. A.* 1900, i, 533. *J. Soc. Chem. Ind.* 19, 502-8. Composition of Petroleum. From Canadian petroleum sulfur compounds were isolated that could be oxidized to sulfones.

138 Magidson, O. Y., and Susskind, B. *C. A.* 1928, 4508. *Trans. Sci. Chem. Pharm. Inst. (Moscow)* 6, 21-8. Triphenyl Stibine Sulfide. Prepared in good yields by Michaelis and Reese's method.

139 Mann, F. G., Pope, W. J., and Vernon, R. H. *C. A.* 1921, 2413. *J. Chem. Soc.* 119, 634-46. Interaction of Ethylene and Sulfur Monochloride. The mechanism of the reaction is studied and discussed.

140 Mann, F. G., and Pope, W. J. *C. A.* 1922, 2110. *J. Chem. Soc.* 121, 594-603. Production and Reactions of β, β' -Dichlorodiethyl Sulfide.*

141 Mansfield, W. *B. A.* 1887, 122. *Ber.* 19, 2658-68. Derivatives of Diethylene Disulfide. Continuation of former work.

142 Martynowicz, Z. *C. A.* 1911, 1600. *Kosmos* 35 (*Rad.-Festb.*) 594-6. p-Xylyl Sulfide and its Derivatives. The preparation of the sulfide, its sulfone and sulfoxide are given.

143 Mauthner, F. *B. A.* 1905, i, 461. *Ber.* 38, 1411-5. Phenothioxines.*

144 Mauthner, F. *B. A.* 1906, i, 421. *Ber.* 39, 1347-51. α -o-Dihydroxydiphenyl Sulfide.*

145 Meyers, J. E., and Stephen, H. *C. A.* 1920, 1822. *J. Soc. Chem. Ind.* 39, 65-6T. Synthesis of β, β' -Dichlorodiethyl Sulfide.*

146 Meyer, V. *B. A.* 1885, 515. *Ber.* 18, 217-8. Synthesis of Thiophene. Ethyl sulfide passed through red hot tube gives liquid testing for thiophene. Similar results from ethylene, coal gas or petroleum vapors over heated pyrites. Also produced from crotonic acid, normal butyric and valeric acids and phosphorus sulfide. No product from isobutyric acid.

147 Meyer, V. *B. A.* 1886, 534. *Ber.* 19, 628-32. The Thiophene Group. Mostly a review of work of students. Prepared β, β -dichlorodiethyl sulfide, but did not get a pure product when treating with ethyl in sodium malonate to close the ring.

148 Meyer, V. *B. A.* 1887, 857. *Ber.* 20, 1729-31. Physiological Action of Chlorinated Ethyl Sulfides.

Dichlorethyl sulfide causes intense inflammation and suppuration when in contact with the skin or when breathed. The monochloro-derivative shows similar but feeble action while ethyl sulfide is without action.

149 Michael, A. B.A. 1877, i, 188. Ber. 9, 1267. Action of Potassium Sulphydrate on Chloral Hydrate.
Formed compound consistent to the substituted sulfide $\text{CCl}_3 \cdot \text{CHOH} - \text{S} - \text{CHOH} \cdot \text{CH}_3$.

150 Michaelis, A. B.A. 1872, 982. Ann. Chem. Pharm. 164, 9-45. On the Constitution of Phosphorus Compounds, I.
Complex reactions of $\text{P}_2\text{S}_3\text{Br}_4$ with ethyl alcohol to form compounds containing SET group of rather complex nature.

151 Michels, W. B.A. 1893, i, 30. Ber. 25, 3048-55. Seleno- and Thio-derivatives of Ethylamine.
Sulfides such as phthalimidoethyl benzyl sulfide are prepared and constants given.

152 Moslinger, W. B.A. 1876, ii, 393. Ber. 9, 998-1008. Some New Octyl Derivatives.
Octyl alcohol from plant source. Octyl sulfide from potassium sulfide and octyl chloride. B.p. above 310° with decomposition. Crystalline compound with HgCl_2 . Barium octyl sulfate sparingly soluble in alcohol. Potassium octyl sulfate soapy to touch and easily soluble in water.

153 Mumford, S. A., and Phillips, J. W. C. C.A. 1928, 1325. J. Chem. Soc. 1928, 155-62. Chlorination Products of β, β' -Dichlorodiethyl Sulfide.*

154 Naik, K. G., and Avasare, M. D. C.A. 1923, 542. J. Chem. Soc. 121, 2592-5. Formation and Properties of Dithioketones ($\text{R}_2\text{C:S:S}$) and Dithioethers ($\text{R}_2\text{S:S}$).*

155 Nasini, R., and Scala, A. B.A. 1887, 753. Gazz. chim. ital. 17, 72-8. Molecular Refractive Energies of Derivatives of Carbon Disulfide.
Measured allyl sulfide, ethereal salts of xanthic acid, and thiocarbonates.

156 Nasini, R., and Scala, A. B.A. 1889, 115. Gazz. chim. ital. 18, 62-72. Sulfines and the Valency of Sulfur.
States that the compound diethylmethylsulfine iodide is different if prepared from diethyl sulfide and methyl iodide or from methylethyl sulfide and ethyl iodide. Compare work of Klinger and Maassen (B.A. 1888, 357).

157 Nekrasov, V. C.A. 1928, 384. J. prakt. Chem. 117, 211-3. Nitrile of Thiodipropionic Acid.*

158 Nekrasov, V. V. C.A. 1928, 3390. J. Russ. Phys. Chem. Soc. 59, 921-4. β, β' -Dicyanodiethyl Sulfide.
Preparation and properties given.

159 Nicolet, B. H., and Willard, I. D. C.A. 1922, 4193. Science 53, 217. A New Type of Nitrogen-Sulfur Com-

pounds; The Action of Chloramine-T on Organic Sulfides.
 Et_2S and chloramine-T in boiling alcohol give NaCl and a compound probably $\text{MeC}_6\text{H}_4\text{SO}_2\text{NH}_2 \cdot \text{SET}_2$ since it is hydrolyzed to $\text{p-MeC}_6\text{H}_4\text{SO}_2\text{NH}_2$ and a product which on reduction gives Et_2S and which is presumed to be Et_2SO .

160 Nietzki, R., and Bothof, H. B.A. 1897, i, 36. Ber. 29, 2774-5. Amidodi-phenyllic Sulfides.
Prepared dinitro diphenyllic sulfide by the action of sodium sulfide on paranitro-chlorobenzene in alcoholic solution. Reduce to amido.

161 Otto, R. B.A. 1879, 926. Ber. 12, 1175-7. Constitution of Sulfotoluide.
Discusses preparation of isomers.

162 Otto, R., and Damkohler, H. B.A. 1885, 537. J. prakt. Chem. [2] 30, 321-66. Disulfones.
Disulfones formed from the coupling of $(\text{C}_6\text{H}_5\text{SO}_2\text{C}_2\text{H}_4 -)$ with oxygen, ammonia, or sulfur were prepared. Also the tolyl derivatives were prepared.

163 Otto, R., and Rossing, A. B.A. 1886, 861. Ber. 19, 1839-40. Formation of Triethylsulfine Bromide from Ethyl Sulfide and Ethyl Bromide at Ordinary Temperature.
Reacts slowly.

164 Otto, R., and Engelhardt, E. B.A. 1887, 263. Ber. 19, 3138-41. Non-existence of Claesson's Phenylsulfine-acetic Acid.
Said by authors to be mixture of un-oxidized phenylthioglycollic acid and phenylsulfoneacetic acid.

165 Otto, R., and Troger, J. B.A. 1893, i, 416. Ber. 26, 993-6. Non-existence of Stenhouse's Phenylthiosulfuric Acid. Sulfonic Acids of Phenyl Sulfides. Bunte's salt.
Phenyl sulfide heated with equal volume strong sulfuric acid forms disulfonic acid. Sulfide with 1 mol. phenyl sulfonic acid forms sulfonic acid with 2 mol. disulfonic acid.

Bunte's salts (sodium ethyl thiosulfate) can be obtained in 90% yield by shaking ethyl bromide with saturated solution of sodium thiosulfate at 35°. Method given.

166 Patein, G. B.A. 1889, 234. Bull. soc. chim. 50, 201-6. Sulfines.
Methyl sulfide adds 2 atoms of iodine. Properties studied. See abstract.

167 Paterno, E., and Oglialoro, A. B.A. 1874, 459. Gazz. chim. ital. 3, 533-41. Researches on Chloral.
Obtained product differing from Byas-son (*Compt. rend.* 74, 1290) and Hagemann (*Ber.* 5, 154). Product formed with PCl_5 yields pentachlorethane. May be sulfide carrying hydroxyl groups.

168 Phillips, F. C. B.A. 1901, i, 444. J. Am. Chem. Soc. 23, 250-8. Compounds of Methyl Sulfide with Haloids of Metals.
Forms compounds with HgCl_2 , CuCl , PdCl_2 , AuCl . Decomposition on heating reported. Solubility.

169 Phillips, J. W. C., Davies, J. S. H., and Mumford, S. A. *C. A.* 1929, 2932. *J. Chem. Soc.* 1929, 535-49. Chlorination Products of β, β' -Dichlorodiyethyl Sulfide. Various chlorination products and their properties given.

170 Pope, W. J. *C. A.* 1920, 173. *J. Soc. Chem. Ind.* 38, 344-5R. Mustard Gas. Article contains brief historical outline dealing with dichlorodiyethyl sulfide.

171 Pope, W. J. *C. A.* 1920, 535. *J. Soc. Chem. Ind.* 38, 432-3R. Further Note on Mustard Gas.*

172 Pope, W. J., and Smith, J. L. B. *C. A.* 1922, 2841. *J. Chem. Soc.* 121, 1166-70. Chlorinated Dialkyl Sulfides. Amylenes react with S_2Cl_2 below 20° to form disulfides. See abstract for various sulfides.

173 Posner, T. *B. A.* 1899, i, 604. *Ber.* 32, 1239-51. Disulfones. I, Nitrogen Derivatives of Sulfonal. Prepared $NH_2 \cdot CH_2 \cdot CHMe(SO_2Et)_2$ and derivatives.

174 Posner, T., and Fahrenhorst, J. *B. A.* 1900, i, 16. *Ber.* 32, 2749-69. Disulfones. II, Aminosulfonal and its Derivatives and Homologs. Nitrogen derivatives as stated. See abstract.

175 Posner, T. *B. A.* 1901, i, 88. *Ber.* 33, 3165-8. Disulfones. V, Acetophenone and Benzophenone Disulfones. Formed ethyl sulfones on oxidation of mercaptal. Both acetophenone and benzophenone gave derivatives.

176 Pummerer, R. *C. A.* 1909, 2457. *Ber.* 42, 2275-82. Bromo Additive Products of Arylthioglycolic Acid. When phenylthioglycolic acid is treated with Br_2 in CS_2 , phenyl thioglycolic acid dibromide is formed. On exposure to air HBr is evolved. Tolylthioglycolic acid behaves similarly.

177 Ray, P. C., and Ray, K. C. B. *C. A.* 1926, 1569. *Quart. J. Indian Chem. Soc.* 2, 178-90. Varying Valency of Platinum with Respect to Mercaptanic Radicals, I.*

178 Ray, P. C., Guha, B. C., and Bose-Ray, K. C. *C. A.* 1926, 3659. *Quart. J. Indian Chem. Soc.* 3, 155-60. Varying Valency of Platinum with Respect to Mercaptanic Radicals, III.*

179 Ray, P. C., and Bose-Ray, K. C. *C. A.* 1926, 3687. *Quart. J. Indian Chem. Soc.* 3, 73-4. Triethylene Trisulfide and 1,4-Dithian. Polemic against Bennett and Berry (*C. A.* 1925, 2027).

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185 Schoeller, C. *B. A.* 1875, 258. *Ber.* 7, 1274. Aromatic Sulfines. Methyl iodide and dibenzylsulfide when heated form trimethyl sulfine iodide and benzylidimethyl sulfine iodide. Benzyl iodide is also formed. Ethyl iodide does not react as rapidly but forms diethyl benzyl sulfine iodide.

186 Schonberg, A. *C. A.* 1924, 983. *Ber.* 56B, 2275. Preparation of Biphenylene Sulfide by the Action of Sodaamine on Diphenyl Sulfoxide. Former prepared by action of $SOCl_2$ on benzene in presence of $AlCl_3$. Product then treated with $NaNH_2$ in $PhMe$ which gave diphenylene sulfide.

187 Schonberg, A., Rosenbach, A., and Schutz, O. *C. A.* 1927, 2674. *Ann.* 454, 37-46. Organic Sulfur Compounds. V, Action of Grignard Solutions on Aromatic Thioketones.*

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192 **Smiles, S., and Hilditch, T. P. C. A. 1907, 2694.** *Proc. Chem. Soc.* **23**, 161. *p*-Cresol Sulfoxide and Sulfide. Former is formed by action of *p*-cresol, AlCl_3 and thionyl chloride. Sulfide formed by reduction of sulfoxide.

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195 **Smythe, J. A. C. A. 1913, 976.** *J. Chem. Soc.* **101**, 2076-82. Oxidation of Some Benzyl Compounds of Sulfur. The compounds were dissolved in AcOH and 30% H_2O_2 used. With 1 equivalent of H_2O_2 , sulfoxides were formed. With 4 equivalents H_2O_2 , sulfones were formed.

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197 **Steinkopf, W., Herald, J., and Stohr, J. C. A. 1920, 3419.** *Ber.* **53B**, 1007-12. β, β' -Dichloroethyl Sulfide and Some of its Derivatives. Various substitutions were made with Br, SCN, and R groups. Effect of oxidizing agents studied.

198 **Stromholm, D. B. A. 1900, i, 12.** *Ber.* **32**, 2892-2911. Diethylene Disulfidethetine. Prepared from diethylene disulfide and monobromacetic acid. Studied stability and derivatives.

199 **Spica, P. C. A. 14, 3648.** *Gazz. chim. ital.* **49**, ii, 299-302. β, β' -Dichloroethyl Sulfide. Its action with CaOCl_2 , KMnO_4 , HNO_3 and H_2O_2 given. Also tests for the sulfide.

200 **Suter, F. B. A. 1895, i, 624.** *Z. physiol. Chem.* **20**, 562-3. Benzylecysteine. Prepared from benzylchloride, cysteine, and soda at ordinary temperature. Evolves ammonia when boiled with soda.

201 **Tafel, J., and Mauritz, A. B. A. 1891, 302.** *Ber.* **23**, 3474-5. Phenacyl Sulfide. Prepared from bromacetophenone and sodium sulfide. The carbonyl oxygen reacts with hydroxylamine and phenylhydrazine.

202 **Tassinari, G. B. A. 1892, 1316.** *Gazz. chim. ital.* **22**, 504-7. Constitution of the Dihydroxythiobenzenes. See abstract for various methods of preparation.

203 **Tassinari, G. B. A. 1893, i, 461.** *Gazz. chim. ital.* **23**, i, 191-6, see *B. A. 1892*, 1396. Constitution of Dihydroxythiobenzenes. Discusses nitration products of diphenyl sulfone as to constitution.

204 **Thierry, E. H. C. A. 1926, 984.** *J. Chem. Soc.* **127**, 2756-9. Sulfur Compounds Removed from Persian Petroleum By Means of Sulfuric Acid. Tetra- and penta-methylene sulfide were definitely isolated. These were identified by their MeI , HgCl_2 , H_2PtCl_6 and sulfonium iodide and mercuriiodide derivatives. MePrS or iso- PrMeS was also probably present.

205 **Thomas, J. S., and Riding, R. W. C. A. 1925, 464.** *J. Chem. Soc.* **125**, 2214-9. Organic Polysulfides. II, The Action of Anhydrous Potassium Pentasulfide on Allyl Iodide and on Some Aromatic Halogen Compounds. Various sulfides and their halogen derivatives are given.

206 **Thompson, T. G., and Kopp, F. J. C. A. 1921, 54.** *J. Ind. Eng. Chem.* **12**, 1056-7. Pressures Produced by the Action of Sulfur Monochloride on Di-chloroethyl Sulfide.*

207 **Thompson, T. G., and Odeen, H. C. A. 1921, 54.** *J. Ind. Eng. Chem.* **12**, 1057-62. The Solubility of β, β' -Dichloroethyl Sulfide in Petroleum Hydrocarbons and its Purification by Extraction with These Solvents.*

208 **Thompson, T. G., Black, J. H., and Sohl, G. T. C. A. 1921, 1720.** *J. Am. Chem. Soc.* **43**, 877-9. Intersolubility of β, β' -Dichloroethyl Sulfide and Ethyl Alcohol. Tables and curves are given.

209 **Thorpe, T. E., and Jones, L. M. J. Chem. Soc. Trans. 1893, 273-92.** The Thermal Expansion and Specific Volumes of Certain Paraffins and Paraffin Derivatives. Measured dimethyl sulfide.

210 **Troeger, J., and Budde, C. B. A. 1902, i, 775.** *J. prakt. Chem.* [2] **66**, 130-52. Aryl-sulfonated Alcohols and Acids. From ethylene bromide and xylolysulfinate oxidized to disulfone.

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212 **Uyeda, Y., and Reid, E. E. C. A. 1921, 674.** *J. Am. Chem. Soc.* **42**, 2385-9. A Sulfide Acid or the Butyl Ester of Thioglycolic Acid. Prepared from sodium butyl mercaptide and CICH_2COOH . Various derivatives given.

213 **Uyeda, Y., and Kamon, J. C. A.** 1924, 3171. *J. Chem. Soc. Japan* **44**, 1061-70. Sulfide Acid. II. Isobutyl Ether of Thioglycollic Acid. Its preparation and various derivatives given.

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215 **Wallach, O., and Borsche, W. B. A.** 1898, **i**, 301. *Ber.* **31**, 338-9. Sulfonals of Cyclic Ketones. Prepared pentanonesulfonal from cyclopentanone, ethyl mercaptan, and HCl and then treating the product with permanganate. Methyl and ethyl pentanones prepared as well as methyl hexanonesulfonal and heptanonesulfonal.

216 **Waterman, H., and Tussenbroek, M. van.** *C. A.* 1927, 1540. *Brennstoff-Chem.* **8**, 20-1. Desulfurization with Silica Gel. Results given when Et_2S in benzene was treated with silica gel.

217 **Weedon, W. S., and Doughty, H. W. B. A.** 1905, **i**, 345. *Am. Chem. J.* **33**, 386-430. Diphenylsulfone-o-carboxylic Acid and Related Compounds.*

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219 **Whitner, T. C., and Reid, E. E.** *C. A.* 1921, 1714. *J. Am. Chem. Soc.* **43**, 636-8. A Sulfide Alcohol or Butylmercapto-ethyl Alcohol. Its preparation and properties given.

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222 **Wilson, R. E., Fuller, E. W., and Schur, M. C.** *C. A.* 1923, 910. *J. Am. Chem. Soc.* **44**, 2867-78. Solubility and Rates of Hydrolysis of Mustard Gas in Water. At 25° the solubility of the gas in water is 0.0043 mol. per liter. Hydrolysis of mustard gas in water is a 2-stage reaction.

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GROUP 15

THIOPHANES AND POLYMERS (PRIMARILY RING SULFURS AND POLYMERS)

1 **Braun, J. V. C.A. 1911, 696.** *Ber.* 43, 3220-6. Cyclic Sulfides, II.

1, 4-Diiodopentane reacts with conc. aqueous K_2S giving α -methyltetrahydrothiophene, b. p. 134°; methiodide, m. p. 172°-173°; and chloroplatinate, m. p. 197°; 1, 6-Diiodohexane and K_2S give $C_6H_{12}S$; methiodide, m. p. 147°; chloroplatinate, m. p. 193°; and thiochromane, b. p. 128°-130°, 15 mm. $KMnO_4$ gives sulfone of latter sulfide.

2 **Calingaert, G. C.A. 1922, 3870.** *Bull. soc. chim. Belg.* 31, 109-11. A Homolog of Ethylene Sulfide: Trimethylene Sulfide.

A mobile colorless liquid, b. p. 145°-150°.

3 **Delepine, M. C.A. 1920, 3226.** *Compt. rend.* 171, 36-8. Ethylene Sulfide.

Ethylene chlorothiocyanate is agitated with aqueous Na_2S and the C_2H_4S removed with steam. Colorless liquid, strong odor, insoluble in water, b. p. 55°-56°. Liquid becomes turbid even in dark after a few weeks. MeI gives cryst. compound.

4 **Grishkevich-Trokhimovskii, E. C.A. 1917, 784.** *J. Russ. Phys. Chem. Soc.* 48, 880-901. Sulfides with Four-membered Nucleus.

Trimethylene sulfide, α -methyltrimethylene sulfide, and α , α -dimethyltrimethylene sulfide given. The reactions of the last two with MeI , $HgCl_2$, and $KMnO_4$ given.

5 **Grishkevich-Trokhimovskii, E. C.A. 1917, 785.** *J. Russ. Phys. Chem. Soc.* 48, 901-28. Sulfides with a Five-membered Nucleus.

Tetramethylene sulfide, tetrahydro- α -thiotolene, tetrahydro- β -thiotolene, meso-tetrahydro- α , α -thioxene and tetrahydro- α , β -thioxene- α -carboxylic acid given. Action of MeI , $HgCl_2$ and $KMnO_4$ given.

6 **Grishkevich-Trokhimovskii, E. (with Tzuikina, O.) C.A. 1917, 786.** *J. Russ. Phys. Chem. Soc.* 48, 928-43. Sulfides with a Six-membered Nucleus.

Pentamethylene sulfide and α -methylpentamethylene sulfide are given and also their reactions with MeI , $HgCl_2$, dilute HNO_3 , $KMnO_4$, and Br .

7 **Grishkevich-Trokhimovskii, E. C.A. 1917, 786.** *J. Russ. Phys. Chem. Soc.* 48, 944-50. Hexamethylene Sulfide.

$C_6H_{12}S$, b. p. 169°-171°. Forms iodomethylate, $HgCl_2$ compound, and sulfone with $KMnO_4$.

8 **Grishkevich-Trokhimovskii, E. C.A. 1917, 787.** *J. Russ. Phys. Chem. Soc.* 48, 951-9. Rupture of the Nucleus of Cyclic Sulfides.

Object of work was to determine whether Hoffmann's reaction (*Ber.* 14, 661) would be effective in rupturing the nucleus of cyclic sulfides. See abstract.

9 **Grishkevich-Trokhimovskii, E. C.A. 1917, 787.** *J. Russ. Phys. Chem. Soc.* 48, 959-74. Behavior of Dihalogen Derivatives with Alkali Sulfides and General Nature of the Resulting Sulfides.

Author tabulates cyclic sulfides and their general properties and compares them with similarly constituted oxides and imines. In all 3 cases the 3-membered rings are unstable, readily polymerizing to 6-membered rings or still larger rings. Many other details given.

10 **Lanfry, M. C.A. 1911, 3226.** *Compt. rend.* 153, 73-6. Hydroxythiophenes.

Thiophene in $AcOH$ solution when boiled in certain concentration H_2O_2 , yields dihydro- and tetrahydroxy-thiophene. Action of alkalies, HNO_3 , H_2SO_4 , Br and Zn or Na in $NaOH$ given.

11 **Mabery, C. F., and Quayle, W. O. B.A. 1906, i, 394.** *Am. Chem. J.* 35, 404-32. Composition of Petroleum Sulfur Compounds and Unsaturated Hydrocarbons in Canadian Petroleum.

Thiophanes. Ring sulfur compounds. See abstract for details.

12 **Mansfield, W. B.A. 1886, 525.** *Ber.* 19, 696-702. Formation of Closed Chains: Compounds of Diethylene Disulfide.

Reaction between ethylene bromide and sodium sulfide gives polymer. To get the disulfide boil with phenol.

13 **Massan, O. J. Chem. Soc. Trans.** 1886, 233-49. On Sulfine Salts Containing the Ethylene Radical. I, Diethylenesulfidemethylsulfine Salts.

Prepared diethylene disulfide from ethylene bromide and sodium sulfide in alcohol. Reflux. Steam distill. 37% yield. This adds one mol. of methyl iodide. Studied salts of these.

14 **Massan, O. J. Chem. Soc. Trans.** 1886, 249-54. On Sulfine Salts Containing the Ethylene Radical. II, Dehn's Reaction Between Ethylene Bromide and Ethyl Sulfide.

Discussion of polymers of ethylene sulfide and its reaction with bromine.

CROSS REFERENCES

Group 2—9; Group 5—107; Group 10—98, 400, 411, 426; Group 14—5, 6, 21, 137, 147, 204.

GROUP 16

SULFOXIDES AND DISULFOXIDES

1 Bamberger, E., and Rising, A. *B. A.* 1901, i, 201. *Ber.* 34, 228-41. Action of Toluene p-Sulfinic Acid on Nitrosobenzene. Toluene p-sulfinic acid on nitrosobenzene in alcohol, acetic acid, or chloroform gives: 1. p-amino phenol; 2. aniline; 3. p-aminophenol toluene p-sulfonate; 4. p-aminophenyl toluene p-sulfonate; 5. β -tolylsulfonyl β -phenylhydroxylamine; 6. p-toluene disulfoxide; and 7. a neutral substance.

2 Bamberger, E., and Rising, A. *B. A.* 1901, i, 202. *Ber.* 34, 241-53. Action of p-Tolylsulfinic Acid on β -Phenylhydroxylamine. Products similar to those obtained with nitrosobenzene (*B. A.* 1901, i, 201).

3 Barnett, E. deB., and Smiles, S. *C. A.* 1909, 2966. *J. Chem. Soc.* 95, 1253-66. Intramolecular Rearrangement of Diphenylamine Sulfoxides. By heating thiadiphenylamine with fuming HNO_3 for 2 hours, tetraniidotriphenylamine sulfoxide results. By dissolving thiadiphenylamine in acetone and adding a little NaOEt and H_2O_2 , diphenylamine o-sulfoxide results.

4 Bell, E. V., and Bennett, G. M. *C. A.* 1927, 3599. *J. Chem. Soc.* 1927, 1798-803. Cis-trans-isomerism of Disulfoxides. Oxidation of 1,4-dithian by H_2O_2 in glacial AcOH studied.

5 Bell, E. V., and Bennett, G. M. *C. A.* 1929, 4202. *J. Chem. Soc.* 1928, 3189-92. Stereoisomerism of Disulfoxides and Related Substances. III, Some Pairs of Aromatic Disulfoxides.* Various derivatives given.

6 Chivers, J. C. A., and Smiles, S. *C. A.* 1928, 1973. *J. Chem. Soc.* 1928, 697-702. Derivatives of 1,3-Dithiolan and of 1,3-Dithian. Various derivatives given.

7 Ekstrand, A. G. *B. A.* 1885, 170. *Ber.* 17, 2601-4. A Sulfoxide of Naphthalene. A compound was obtained as a side product when distilling a mixture of potassium α - and β -naphthalene sulfonates with potassium ferrocyanide that contained sulfur and was supposed to be naphthalenedinaphthylsulfoxide. Its reactions were studied.

8 Escales, R. *B. A.* 1885, 798. *Ber.* 18, 893-8. Action of Phenylhydrazine on Sulfinic Acids. When an aqueous solution of phenylhydrazine hydrochloride is heated on a water bath with benzene sulfinic acid, benzene disulfoxide and phenylbenzene sulfoxide are formed. Similar to decomposition of benzene sulfinate to benzene disulfoxide and benzene sulfonic acid.

9 Fries, K., and Vogt, W. *C. A.* 1912, 3442. *Ann.* 381, 312-37. Thianthrene. Method of preparation given and its action with FeCl_3 , HNO_3 , H_2SO_4 , and HCl .

10 Fromm, E., and Palma, J. de Seixas. *B. A.* 1906, i, 819. *Ber.* 39, 3308-17. Benzylsulfinic Acid and Dibenzylidisulfoxide. See next reference.

11 Fromm, E., and Palma, J. de Seixas. *C. A.* 1907, 293. *Ber.* 39, 3308-17. Benzylsulfinic Acid and Benzylidisulfoxide. The properties and various derivatives of the acid are given. The Pb salt was more stable and was used in the preparation of derivatives.

12 Fromm, E. *C. A.* 1909, 2142. *Ber.* 41, 4385. Benzaldehydesulfoxylate (Correction). By the action of benzyl chloride and NaOH on the sulfoxylate, the compound $\text{C}_7\text{H}_7\text{SO}_2\text{Na}$ was obtained. It proved to be Na benzylsulfonate.

13 Fromm, E. *C. A.* 1912, 1600. *Z. angew. Chem.* 24, 1125. Basic Properties of Sulfoxides and Disulfoxides. H_2O decomposes R_2SCl_2 and R_2SBr_2 forming sulfoxides. R_2Sl_2 are similarly decomposed by AcOAg . Original dihalides are regenerated by heating sulfoxides with HBr and HI . Disulfides (dibenzyl) yield with Br_2 and I, $\text{C}_7\text{H}_7(\text{SBr}_2)_2\text{C}_7\text{H}_7$ and $\text{C}_7\text{H}_7(\text{SI})_2\text{C}_7\text{H}_7$, which with water or AcOAg yield the disulfoxide.

14 Gutmann, A. *C. A.* 1914, 1587. *Ber.* 47, 635-9. Action of Alkaline Reducing Agent on Disulfoxides and Sulfoxides. Authors showed that disulfoxides have unsymmetrical structure, $\text{RS} \cdot \text{O}_2 \cdot \text{SR}$ rather than symmetrical structure $(\text{RS} \cdot \text{O} \cdot \text{S})_2$.

15 Halssig, F. A. *B. A.* 1898, i, 141. *J. prakt. Chem.* 56, 213-41. Paratoluene-sulfinic Acid. Ammonia passed into solution of acid in benzene forms ammonium salt which decomposes into paratoluenesulfonic acid and paratoluene disulfoxide. Other reactions also studied as with phenylhydrazine.

16 Hilditch, T. P. *C. A.* 1909, 2679. *J. Chem. Soc.* 93, 1524-7. Aromatic α -Disulfones. Best prepared by slowly adding calculated amount KMnO_4 to solution of the sulfinic acid in glacial AcOH with constant cooling. Main product is sulfonic, but from 17% to 40% of the disulfone is obtained. Various ones given.

17 Hinsberg, O. *C. A.* 1909, 650. *Ber.* 41, 4294-7. Constitution of Disulfoxides, II. Believed to support symmetrical formula RSOSOR for sulfoxides.

18 Hinsberg, O. *C. A.* 1912, 2403. *J. prakt. Chem.* 85, 337-52. Sulfoxide and Sulfone Groups. The preparation and properties of trimethylene trisulfoxide, diphenylsulfoxide methane, and phenylsulfoxide phenylsulfone methane.

19 **Miller, C. J., and Smiles, S. C. A.** 1925, 1133. *J. Chem. Soc.* **127**, 224-33. Constitution of Disulfoxides.*

20 **Otto, R., and Troger, J. B. A.** 1891, 718. *Ber.* **24**, 478-88. Aromatic Sulfonic Iodides. Prepared paratoluenesulfonic iodide. This with molecular silver gave, instead of a disulfone as was hoped, paratoluene sulfoxide and paratoluenesulfonic anhydride.

21 **Pauly, C., and Otto, R. B. A.** 1877, i, 463. *Ber.* **9**, 1639-41. New Formations of Benzene- and Toluene-dioxysulfide. These are formed together with sulfonic acids when sulfonic acids are boiled with water or when sodium salts are treated with sulfuric acid or phosphorus pentoxide. On boiling with potash gives sulfonic and sulfinic acid.

22 **Smiles, S., and Bain, A. W. C. A.** 1907, 2694. *Proc. Chem. Soc.* **23**, 161. Phenol p-Sulfoxide. Properties compared with those obtained by Schall and Uhl. (*Ber.* **25**, 1892-3.)

23 **Smiles, S., and Gibson, D. T. C. A.** 1924, 978. *J. Chem. Soc.* **125**, 176-83. Constitution of Disulfoxides. Three formulas are proposed for disulfoxides and agreements given for them.

24 **Spring, W., and Winssinger, C. B. A.** 1882, 938. *Ber.* **15**, 445-7. Action of Chlorine on Sulfonic Derivatives. Iodine trichloride on ethyl sulfonic acid first yields dichlorsulfonic acid and then excess gives hexachlorethane. Diethylsulfone is not attacked by chlorine but excess iodine trichloride gives hexachlorethane. Less ICl_3 yields tetrachlorethane, tri-

chlorothane, monochlordinethyl sulfone, sulfur dichloride, and some unattached diethyl sulfone. Ethyl sulfoxide and chlorine react rapidly forming ethyl chloride and ethyl sulfonic chloride. With dry ethylsulfoxide, chlorine produces ethyl chloride and a chlorinated sulfonic acid.

25 **Spring, W., and Winssinger, C. B. A.** 1883, 659. *Ber.* **16**, 326-30. Action of Chlorine on Sulfo Derivatives and Organic Oxysulfides. Chlorine does not react with pure propylsulfonic acid. Does react with iodine trichloride. Forms first chlorosulfonic acid then various chlorinated products of propane. See abstract for steps in reaction.

26 **Troeger, J., and Voigtländer-Tetzner, W. B. A.** 1897, i, 223. *J. prakt. Chem.* [2] **54**, 513-32. Orthotoluene-sulfinic Acid. Produced by the action of zinc dust and water on the sulfochloride. Prepared alkylsulfones, disulfoxide.

CROSS REFERENCES

Group 2—62, 110; **Group 6**—7, 34; **Group 7**—7, 11, 20, 22, 23, 25; **Group 8**—15; **Group 10**—19, 20, 23, 34, 46, 47, 57, 66, 73, 82, 116, 128, 134, 152, 153, 154, 155, 157, 159, 165, 169, 173, 176, 180, 192, 206, 220, 267, 283, 287, 291, 306, 308, 327, 339, 390, 392, 428, 437, 438, 439, 441, 443; **Group 11**—4, 13, 32, 33, 34; **Group 12**—28, 30, 37, 39, 42, 44, 49, 50, 52, 55, 67, 68; **Group 13**—7, 8, 9; **Group 14**—25, 34, 42, 43, 66, 74, 75, 78, 79, 80, 81, 86, 93, 95, 96, 97, 98, 104, 110, 125, 140, 142, 143, 159, 186, 192, 194, 195, 197, 199, 217, 223; **Group 15**—1, 5, 6.

GROUP 17

SULFONES

1 **Annaheim, J. B. A.** 1874, 795. *Ann. Chem. Pharm.* **172**, 28-61. Oxysulfonylbenzide and Derivatives. Heat 2 parts phenol and 1 part fuming H_2SO_4 for 3 to 5 hours to 180° - 190° . Gives method of purification of sulfone formed. Derivatives studied.

2 **Annaheim, J. B. A.** 1877, i, 79. *Ber.* **9**, 1148-50. Crystalline Form, Specific Gravity, and Molecular Volume of Oxysulfonylbenzide. Prepared large crystals, calculated atomic volumes of elements. Tetrachlor-, brom-, and iodo-derivatives, also prepared.

3 **Autenrieth, W. B. A.** 1891, 203. *Ann.* **259**, 332-57. Sulfone Derivatives of the Crotonic Acids. Reports on stability of acids and salts.

4 **Baumann, E., and Kast, A. B. A.** 1889, 1232. *Z. physiol. Chem.* **14**, 52-74. The Relation Between the Chemical Constitution and the Physiological Action of Certain Sulfones. Three classes of disulfones $CH_2(SO_2R)_2$, $CHR'(SO_2R)_2$, and $CRR''(SO_2R)_2$, where R, R', R'' are univalent alcohol radicals. See abstract.

5 **Baumann, E. B. A.** 1891, 1229. *Ber.* **24**, 2272-7. Hydrolysis of Sulfones and Etheare Salts of Benzene Sulfonic Acid. Discusses work of Stuffer, Otto, and Autenrieth. See abstract.

6 **Baumann, E., and Walter, G. B. A.** 1893, i, 458. *Ber.* **26**, 1124-39. Hydrolysis of Sulfones, Sulfonesulfonic and Sulfinolactones. Studied derivatives of trimethylene, ethylene and methylene in combination with sulfone and sulfonic acids. Gives preparation of compounds and reactions. See abstract or original.

7 **Baumann, E. B.A. 1893, i, 684.** *Ber.* 24, 2074-9, see *B.A. 1890*, 25. Oxidation of the Two Trithioacetaldehydes. Discusses the α - and β -trithioacetaldehyde oxidation products to the formation of di- and tri-sulfones. The disulfone sulfide chiefly discussed.

8 **Beckurts, H., and Otto, R. B.A. 1879, 242.** *Ber.* 11, 2066-70. Synthesis of Aromatic Sulfones. Prepared series of sulfones by Friedel and Craft's reaction with hydrocarbon and arylsulfonchloride.

9 **Bell, E. V., and Bennett, G. M. C.A. 1928, 1325.** *J. Chem. Soc.* 1928, 86-92. Stereoisomerism of Disulfoxides and Related Substances. II, Derivatives of 1,4-Dithian. Further proof is given that the 2 dithian dioxides are stereoisomeric.

10 **Braun, J. v. C.A. 1926, 905.** *Ber.* 58B, 2165-8. Cyclic Sulfides. α -Xylylene sulfide, 2,3-dihydroxythiophenene, and homoisothiochroman are given, also the sulfones and methiodides.

11 **Camps, R. B.A. 1892, 591.** *Ber.* 25, 233-47. Trimethylenetrisulfone. Forms sodium derivative which reacts with ethyl iodide to form hexaethyltrimethylene sulfone. See abstract.

12 **Camps, R. B.A. 1892, 592.** *Ber.* 25, 248-57. Trimethylenedisulfonesulfide.*

13 **Chrurstschoff, P. B.A. 1875, 162.** *Ber.* 7, 1167-8. Mixed Sulfones (Aromatic). When benzene sulfonic chloride is heated with naphthalene and zinc dust, naphthylphenylsulfone is formed.

14 **Cleve, P. T. B.A. 1876, ii, 81.** *Bull. soc. chim.* [2] 25, 256. Sulfonaphthalide. Dinaphthylsulfone prepared. Heated in retort with phosphorus pentachloride formed naphthyl chloride and naphthyl sulfonechloride.

15 **Cohen, J. B., and Skirrow, F. W. J. Chem. Soc. Trans. 1899, 887-93.** The Aluminium-mercury Couple. I, Action of Sulfur Chloride on Some Hydrocarbons in Presence of the Couple. Preparation of diphenylene disulfide and sulfone. Studied also action of sulfur chloride on metoxylene, cumene, toluene, and pseudocumene.

16 **Fouque, G., and Laeroix, J. C.A. 1923, 1958.** *Bull. soc. chim.* 33, 180-3. Preparation of Aromatic Sulfones.*

17 **Fromm, E. B.A. 1888, 357.** *Ber.* 21, 185-8. Disulfones. Reactions studied. See abstract or original.

18 **Fromm, E., and Baumann, E. B.A. 1889, 852.** *Ber.* 22, 1035-45. Thio-derivatives of Ketones. H_2S passed into a well-cooled mixture of acetone and concentrated HCl forms trithioacetone. Oxidized to a sulfone (a pentoxide). Tetrathiolopentane is also formed.

19 **Fromm, E. B.A. 1890, 55.** *Ann.* 235, 135-67. Disulfones and Trisulfones. Some are prepared by oxidizing the sulfides. See abstract or original.

20 **Fromm, E., and Erfurt, F. C.A. 1910, 212.** *Ber.* 42, 3823-6. Action of Formaldehyde and Alkali on Sulfones. Diformylidbenzylsulfone unchanged by boiling concentrated sulfuric acid by fusion with alkali, or by Br in CHCl_3 or NaOBr . Diformyl p-tolylbenzylsulfone resembles the dibenzyl derivatives closely. Diformylphenylbenzylsulfone also given.

21 **Gabriel, S. B.A. 1881, 716.** *Ber.* 14, 833-4. Sulfonacetic Acid. Prepared from sodium sulfinate and sodium chloracetate.

22 **Gabutti, E. B.A. 1907, ii, 512.** *J. pharm. chim.* [6] 25, 483-6. Detection of Sulfonal in Trional or Tetronal. Separation due to differential solubility in ether.

23 **Genvresse, P. B.A. 1894, i, 132.** *Bull. soc. chim.* [3] 9, 707-10. Sulfones from Benzylic Alcohol and Benzoic Acid. Gives preparation of dibromditolylsulfone and converting it into dihydroxy- and then dicarboxy-diphenylsulfone.

24 **Genvresse, P. B.A. 1895, i, 284-6.** *Bull. soc. chim.* [3] 11, 501-14. Aromatic Sulfones. Preparations and properties given.

25 **Griess, P., and Duisberg, C. B.A. 1890, 57-60.** *Ber.* 22, 2459-74. Benzidine and Benzidinesulfonesulfonic Acids. Prepared sulfone and sulfonic acids from benzidine.

26 **Haehl. C.A. 1923, 3865.** *Compt. rend.* 177, 194-5. p-Chlorodiphenylsulfone. The constitution of Beckurt and Otto's compound was proved by Haehl by making the same compound through sulfanilic acid.

27 **Hinsberg, O. B.A. 1895, i, 144, 471.** *Ber.* 27, 3259-61; 28, 1315-18. Diphenylsulfone Derivatives. Use powdered quinone in excess of cold aqueous solution of benzenesulfonic acid to form sulfones. See both papers or abstracts.

28 **Hinsberg, O., and Himmelschein, A. B.A. 1896, i, 685.** *Ber.* 29, 2023-9. Hydroxy- and Amido-derivatives of Diphenylsulfone. See abstract on reactions of potassium dichromate on quinol in the presence of benzenesulfonic acid to form 1,4-dihydroxyphenylsulfone. Others also prepared.

29 **Hinsberg, O. C.A. 1916, 63.** *Ber.* 48, 1611-4. Sulfones of the Thiophene Series. Sulfones of tetraphenylthiophene, m.p. 265°, and 3,4-diphenylthiophene, m.p. 182°, are described.

30 **Hinsberg, O. C.A. 1917**, 2673. *Ber.* 49, 2593-4. Diaryldisulfones.
Assumption that diaryldisulfones have structure $\text{RSO}_2\text{SO}_2\text{R}$ is given further support by other reactions.

31 **Hinsberg, O. C.A. 1917**, 2804. *Ber.* 50, 468-73. Reaction Between Aromatic Sulfinic Acids and Di- and Tri-phenyl Carbinals.
The compound was found to be phenyl p, p'-tetramethyldiaminodiphenyl sulfone when Michelor's hydroxyl reagent reacted with sulfinic acids. Above alcohols react in a similar way.

32 **Hinsberg, O. C.A. 1918**, 694. *Ber.* 50, 953-8. Dihydroxydiaryl Sulfones.
Various dihydroxydiaryl sulfones were prepared by action of sulfinic acids on quinones.

33 **Holmberg, B., and Mattison, K. C.A. 1907**, 2233. *Ann.* 353, 123-30. Contribution to Our Knowledge of Some Mercaptal Acids.
Formaldehyde and benzaldehyde condense with mercaptal acids forming methylene- and benzylidene-bisthio acids. On oxidation certain ones yield sulfones.

34 **Jacobsen, O. B.A. 1889**, 40. *Ber.* 21, 2814-9. Pentaethylbenzene and its Decomposition by Sulfuric Acid.
Compare *B.A.* 1887, 680; 1890, 137. Prepared pentaethylbenzene sulfone.

35 **Knoevenagel, E. B.A. 1888**, 705. *Ber.* 21, 1344-54. Negative Nature of Organic Radicals.
Phenylbenzyl sulfone does not react with sodium ethoxide and benzylchloride.

36 **Knoevenagel, E., and Kenner, J. C.A. 1909**, 173. *Ber.* 41, 3315-22. Preparation of Sulfinic Acids.
By the action of SO_2 and AlCl_3 on an aromatic hydrocarbon. Yield around 80%. Acids of 13 aromatic hydrocarbons prepared, and their derivatives. Anisole and phenetole yield also sulfoxides and sulfonium compounds.

37 **Kohler, E. P., and MacDonald, M. B. B.A. 1899**, i, 904. *Am. Chem. J.* 22, 219-26. Disulfones and Ketosulfones.
Aromatic disulfones of the type $\text{RSO}_2\text{-SO}_2\text{R}$ can be prepared by warming sulfonic acid chlorides with the sodium salt of sulfonic acid and sufficient water to form a paste.

38 **Kohler, E. P., and MacDonald, M. B. B.A. 1899**, i, 907. *Am. Chem. J.* 22, 227-39. Action of Sulfonic Chlorides on the Metallic Derivatives of Ethereal Salts of Ketonic Acids.
Prepared paratoluenesulfone acetate and reactions.

39 **Kohler, E. P., and Reimer, M. B.A. 1904**, i, 233. *Am. Chem. J.* 31, 163-84. Additive Reactions of Sulfinic Acids.
Sulfinic acids add readily to aliphatic aldehydes with the formation of hydroxysulfones. These are unstable. See abstract for those prepared.

40 **Kotz, A. B.A. 1900**, i, 369. *Ber.* 33, 1120-7. Reactivity of the Hydrogen Atoms in Disulfones, Trisulfones, and Tetrasulfones.
Compares different types of sulfones and their reactivity.

41 **Lomnitz, E. B.A. 1894**, i, 444. *Ber.* 27, 1667-79. Trimethyltrimethylene-trisulfone.
Prepared by oxidizing α - or β -trithio-acetaldehyde by permanganate in presence of sulfuric acid. Prepared K, Na, Ba, Sr, and Ag salts. Has three replaceable hydrogens. See abstract or original.

42 **Loven, J. M. B.A. 1886**, 222. *Ber.* 18, 3241-2. Action of Nitrous Acid on Sulfonediacetic Acid.
One mol. of sulfone diacetic acid (Loven *B.A.* 1885, 241) and 2 mol. sodium nitrite cause decomposition giving off CO_2 and in solution HCN .

43 **Loven, J. M. B.A. 1896**, ii, 412. *Z. physik. Chem.* 19, 456-64. Affinity Constants of Some Organic Acids.
Organic aliphatic acids having sulfone group in chain, aromatic substituted sulfonamides, and benzenesulfonic acid.

44 **Magnus-Levy, A. B.A. 1893**, i, 714. *Ber.* 26, 2148-50. Action of Formaldehyde on Benzenesulfonamide.
Alcoholic solution of benzenesulfonamide, heated with a 40% aqueous solution of CH_2O and trace HCl , forms tribenzene-sulfone trimethylene triimide.

45 **Manasse, A. B.A. 1902**, i, 348. *Ber.* 35, 1372-4. Diaminosulfonal.
See abstract for preparation.

46 **Martinet, J., and Haehl, A. C.A. 1922**, 557. *Compt. rend.* 173, 775-7. m, m-Dinitrodiphenyl Sulfone.
Obtained by direct nitration of Ph_2SO_2 . Yields on reduction with Sn and HCl , $(\text{m-H}_2\text{NC}_6\text{H}_4)_2\text{SO}_2$. Latter yields $(\text{m-HO-C}_6\text{H}_4)_2\text{SO}_2$ upon diazotization and subsequent hydrolysis.

47 **Meyer, E. von. B.A. 1898**, i, 142. *J. prakt. Chem.* 56, 272. Derivatives of Paratoluenesulfonic Acid.
Action of diazo compounds on paratoluenesulfonic acid to form sulfones.

48 **Meyer, E. von, Nacke, R., and Gmeiner, M. B.A. 1901**, i, 264. *J. prakt. Chem.* [2] 63, 167-83. *Chem. Zentr.* 1901, i, 455-6. p-Toluenesulfonic Acid.
Prepared derivatives.

49 **Meyer, H. C.A. 1924**, 54. *Ann.* 433, 327-50. Aromatic Sulfonic Acids and Sulfones.
Various aromatic sulfones given.

50 **Michael, A., and Adair, A. B.A. 1877**, ii, 612. *Ber.* 10, 583-7. Aromatic Sulfones.
General reaction of phosphoric anhydride at high temperature on a mixture of an aromatic sulfonic acid with a hydrocarbon.

51 **Michael, A., and Adair, A. B.A. 1878**, 415. *Ber.* 11, 116-21. Aromatic Sulfones.
Prepared by action of phosphoric anhydride on arylsulfonic acid and aryl hydrocarbon.

52 Michael, A., and Comey, A. M. *B. A.* 1884, 319. *Am. Chem. J.* 5, 116-9. Properties of Ethylic Phenylsulfonacetates. Prepared from ethylchloracetate and sodium phenylsulfonate on heating in alcohol 4 to 5 hours. Sodium ethylate gives $\text{PhSO}_2\text{CHNaCOOEt}$. This shows PhSO_2 has an effect on the CH_2 group.

53 Michael, A., and Palmer, G. M. *B. A.* 1885, 536. *Am. Chem. J.* 6, 253-7. Action of Sodium Phenylsulfinate on Methylene Iodide. Alcoholic solution of phenylsulfinic acid (2 mol.), methylene iodide (1 mol.), and sodium (1 mol.) dissolved in alcohol was heated 4 to 5 hours at 120°C . Methylenetriphenylsulfone was isolated from oil. Heating 2 equivalents of sodium phenylsulfinate and one of methylene iodide at 180°C , methylphenylsulfone is formed. Reactions of iodosulfone above also studied.

54 Michael, A., and Palmer, G. M. *B. A.* 1885, 986. *Am. Chem. J.* 7, 65-71. Properties of Phenylsulfoneacetates. Heated at 140° yields phenylmethylsulfone. Prepared higher acids by substituting alkyl groups for hydrogen by use of sodium ethoxide and alkyl iodide. See abstract for details of substitution in compound.

55 Michael, A. *B. A.* 1890, 781. *Ber.* 23, 669-71. Replacement of the Sodium in Sodiophenylsulfoneacetate by Alkyls. Explains why Otto and Rossing (*B. A.* 1889, 994) could not repeat former work. Cause—used alcohol containing water and therefore did not follow directions.

56 Michael, A. *B. A.* 1899, i, 816. *J. prakt. Chem.* 1899, ii, 60, 96. Substitution of Alkyl Radicals for Sodium in Ethylic Phenylsulfonesodioacetate. Confirms earlier work.

57 Olivier, S. C. J. *C. A.* 1916, 196. *Chem. Weekblad.* 11, 372-7. Friedel-Craft's Synthesis of Sulfones. A discussion of the mechanism of the reaction given.

58 Olivier, S. C. J. *C. A.* 1916, 1854. *Rec. trav. chim.* 35, 166-79. Dynamic Researches on the Formation of Some Aromatic Sulfones Under the Influence of Aluminum Chloride in a Medium of Benzene Sulfonylchloride.*

59 Olivier, S. C. J. *C. A.* 1918, 1468. *Rec. trav. Chim.* 37, 92-5. Derivatives of Benzene Sulfinic Acid. Complexes such as $\text{p-BrC}_6\text{H}_4\text{SO}_2\text{AlBr}_2$ and $\text{p-BrC}_6\text{H}_4\text{SO}_2\text{Ph}$ were obtained by action of $\text{p-BrC}_6\text{H}_4\text{SO}_2\text{Br}$ on AlBr_3 and Ph_2SO_2 . Compounds are unstable to water or alkalies giving Al, Br, Ph_2SO_2 , and $\text{p-BrC}_6\text{H}_4\text{SO}_3\text{H}$.

60 Otto, R. *B. A.* 1879, 649. *Ber.* 12, 214. Sulfonic Acids Derived from Sulfones. Sulfonates diphenylsulfone forming mono- and di sulfonic acids.

61 Otto, R. *B. A.* 1880, 810. *Ber.* 13, 1272-83. Constitution of the Sulfinic Acids.

Sulfones can be readily prepared by warming an alcoholic solution of a sodium sulfinate with an alcoholic bromide. The conversion of sulfinic acids into sulfones favors the hypothesis that these acids are hydrides and do not contain the hydroxyl group and also that the sulfur atom acts as a hexad and not as a tetrad. Prepared several sulfones. See abstract.

62 Otto, R., and Damkohler, H. *B. A.* 1885, 261. *J. prakt. Chem.* [2] 30, 171-208. Disulfones. Derivatives of ethylene by treatment of ethylene bromide with sodium benzenesulfinate. Nascent hydrogen in acid solution gives no reaction, while with sodium amalgam and water it is converted into sodium benzenesulfinate and ethyl alcohol. Prepared phenylsulfone ethyl alcohol, its hydrogen sulfate, chloride, and oxide.

63 Otto, R. *B. A.* 1885, 535. *Ber.* 18, 246-50. New Synthesis of Aromatic Sulfones. Heat mercury diphenyl with benzenesulfonechloride at 160° in sealed tubes. Yield small of sulfone. Reaction at 254° violent.

64 Otto, R. *B. A.* 1885, 536. *Ber.* 18, 154-62. Formation of Sulfones from Alkylsulfonated Acids of the Series $\text{C}_n\text{H}_{2n}\text{O}_2$. Oxidized phenylsulfone ethyl alcohol by means of potassium dichromate and sulfuric acid and phenylsulfoneacetic acid was formed. Others prepared.

65 Otto, R. *B. A.* 1886, 801. *Ber.* 19, 1641-4. Sulfone-ketones. Monochloracetone on sodium benzenesulfinate yields monophenylsulfone acetone.

66 Otto, R., and Engelhardt, H. *B. A.* 1886, 883. *Ber.* 19, 1835-8. Action of Alkaline Sulfonates on Salts of Dihalogenated Fatty Acids. Sodium dichloracetate (1 mol.) heated with 2 mol. sodium benzenesulfinate yielded $\text{CH}_2\text{Cl} \cdot \text{SO}_2\text{Ph} + \text{NaCl} + \text{NaHCO}_3$. A chlorinated phenylsulfone acetic acid is seemingly unstable.

67 Otto, R., and Rossing, A. *B. A.* 1887, 372. *Ber.* 20, 185-9. Action of Potassium Hydroxide on Phenylmethadiphenylsulfone. On decomposition with alkali forms benzenesulfinic acid and diphenylsulfone-phenylether. Other sulfones mentioned.

68 Otto, R., and Casanova, R. C. *B. A.* 1888, 255. *J. prakt. Chem.* [2] 36, 433-51. Disulfones, $\text{R}'\text{R}''_2(\text{SO})_2$, and $\text{R}''_2(\text{SO}_2)_2$. See *B. A.* 1885, 261 and 537. Prepared by heating sodium ethyl or alkyl sulfinate and ethylene dibromide, or sodium ethylene disulfinate and ethyl bromide or alkyl bromide.

69 Otto, R., and Otto, W. *B. A.* 1888, 282. *J. prakt. Chem.* [2] 36, 401-32. Sulfoneketones. Sulfone ketones behave as ketones forming mercaptone.

70 Otto, R. *B. A.* 1888, 360 and 577. *Ber.* 21, 89-99, 992-8. Analogy Between Ketonic Acids and the Alkyl Sulfones of the Fatty Acids.

First paper deals largely with points of analogy between ketonic acids and the alkyl sulfones of the fatty acids. Second paper describes more experimental work.

71 Otto, R. B.A. 1888, 483. Ber. 21, 658-9. Methylenechlorophenylsulfone ($\text{CH}_2\text{Cl}\cdot\text{SO}_2\text{Ph}$). Prepared from sodium dichloracetate and sodium benzenesulfinate. Reduced with zinc and sulfuric acid to methylphenylsulfone.

72 Otto, R. B.A. 1889, 1186. Ber. 22, 1965-8. Synthesis of Symmetrical Diphenylsulfoneacetone By Means of Tetrachloracetone. Compare R. and W. Otto (B.A. 1888, 282). Prepared by heating symmetrical tetrachloracetone hydrate with sodium benzenesulfinate in dilute alcohol. Yield very small.

73 Otto, R. B.A. 1890, 379-82. J. prakt. Chem. [2] 40, 505-64. Sulfone-derivatives. Study of types of sulfones. See abstract or original.

74 Otto, R., and Rossing, A. B.A. 1890, 1137. Ber. 23, 1647-53. Displacement of the Sodium in Ethyl Sodiophenylsulfone Acetate. Reply to A. Michael (B.A. 1890, 781).

75 Otto, R., and Troger, J. B.A. 1891, 665. Ber. 24, 868-70. Ethylsulfoneacetone and Diethylsulfoneacetone. Prepared primarily to study physiological action. Ethyl sulfoneacetone on hydrolysis with potash gives ethylmethylsulfone and acetic acid. The others prepared on hydrolysis also give a dialkyl sulfone.

76 Otto, R. B.A. 1891, 1067. Ber. 24, 1510. Unsaturated Sulfones. Readily obtained by the action of sodium arylsulfinate on allyl chloride. The phenylallylsulfone is an oil while the paratolyl is a solid.

77 Otto, R. B.A. 1891, 1229. Ber. 24, 1832-6. Hydrolysis of Sulfones. Continuation of previous work. Di- and tri-sulfones.

78 Otto, R., Rossing, A., and Troger, J. B.A. 1893, i, 276. J. prakt. Chem. [2] 47, 94-104. Sulfonic Derivatives of Naphthalene. Gives review of knowledge of 1- and 2-naphthalenesulfonic acids and their reactions. Gives preparation of some sulfones from sodium sulfinate and alkyl iodide.

79 Otto, R., and Troger, J. B.A. 1893, i, 415. Ber. 26, 944-5. Diphenylsulfonefethylic and Ditolylsulfonethylic Oxides. Gives preparation and constants. See R. Otto, J. prakt. Chem. [2] 30, 171 and 321.

80 Otto, R. B.A. 1894, i, 376. J. prakt. Chem. [2] 49, 378-91. Action of Hydrogen Sulfide on Sulfones. Influence of Solvent on Chemical Change. See R. Otto (B.A. 1893, i, 344). Benzenesulfonic chloride is reduced by H_2S in aqueous alcohol, with greater difficulty in ether particularly in absence of water, and with still greater difficulty in methyl alcohol, benzene, or acetic acid. Gives a list of sulfonic chlorides and solvents for reduction. Thiosulfonates and sulfinic acids can be reduced. Sulfones cannot be reduced.

81 Otto, R. B.A. 1895, i, 229. Ann. 283, 181-208. Unsaturated Sulfones: Allylphenylsulfone and allylparatolylsulfone. See B.A. 1891, 1067 and 1229. Prepared from allyl bromide and sodium sulfinate. Derivatives prepared.

82 Otto, R. B.A. 1895, i, 337. Ann. 284, 300-6. Synthesis of Sulfones from Sodium Alkylic Sulfimates by the Action of Potassium Alkyl Sulfates. Use sodium alkyl sulfinate and potassium alkyl sulfate in place of alkyl halide in preparation of sulfone.

83 Parisi, E. C.A. 1925, 2557. Ann. chim. applicata 15, 121-3. The Presence of a Sulfur Compound in Some Grades of Benzene Which Contain No Thiophene. Shown to be diphenylsulfone.

84 Pinnow, J. B.A. 1893, i, 332. Ber. 26, 604-6. (See B.A. 1892, 461.) Action of Benzenesulfonic Chloride on Amidoximes. Decomposition products of a amidoxime-benzenesulphone by boiling water given. Gives preparation of ethenylamidoxime benzenesulfone.

85 Purgotti, A. C.A. 1919, 2515. Ann. scuola superiore agr. Portici [2] 13, 8 p. (1915-16). Some New Compound Halogenated Sulfones. The sulfones were obtained by the action of $\text{p-C}_6\text{H}_4\text{SO}_2\text{Na}$ on halogenated alkyl compounds. A number are given.

86 Recsei, A. C.A. 1928, 233. Ber. 60B, 1836-40. Quinone Disulfones. The above name is applied to compounds of the type $\text{O:Ar:(SO}_2\text{R})_2$. See abstract.

87 Reycher, A. C.A. 1907, 2084. Bull. soc. chim. [4] 1, 417-22. The Action of Trimethylene Trisulfone upon Formaldehyde. Multimolecular combinations seem to be formed. The solutions are colloidal and have a tendency to coagulate.

88 Rossing, A. B.A. 1890, 781. J. prakt. chem. [2] 41, 369-96. Analogy of Ketonic Acids to Sulfonecarboxylic Acids. See abstract for summary of the results of the experiments.

89 Seyewetz, A., and Bloch. C.A. 1907, 1847. Bull. soc. chim. [4] 1, 320-7. The Production of Aromatic Sulfamates and Sulfonamines by Action of Sodium Thiosulfate on Nitro Derivatives. Sulfamates of the formula RNHSO_2M are formed by action of $\text{Na}_2\text{S}_2\text{O}_3$ on nitro compounds. Sulfamates at $170^\circ\text{-}180^\circ$ rearrange to form sulfone amides.

90 Smiles, S., and Hilditch, T. P. C.A. 1907, 1709. J. Chem. Soc. 91, 519-28.

Camphor β -Sulfinic Acid and Camphorylsulfonium Bases. Permanganate converts into d-camphoryl α -disulfone. Certain sulfonium salts were formed.

91 Stein, O. B.A. 1895, i, 54. *Ber. 1894*, 27, 2806-7. Paradiamidodiphenylmethanesulfone. See Eberhardt and Welter (*B. A.* 1894, i, 451). Prepared by action of fuming sulfuric acid on paramidodiphenylmethane. Cryst. m. p. 217°. No coloration given with diazo compounds. Nitrites are therefore recommended in titration of aromatic amines.

92 Stenhouse, J., and Groves, C. E. B.A. 1876, ii, 517. *Chem. News* 32, 151. Preliminary Notice on the Action of Sulfuric Acid on Naphthalene. Shows formation of the sulfone.

93 Stuffer, E. B.A. 1890, 987. *Ber. 23*, 1408-14. Decomposition of Sulfones. Studied disulfone to note the hydrolysis with alkali. Dependent upon carbon chain and groups attached.

94 Troeger, J., and Artman, K. B.A. 1896, i, 569. *J. prakt. Chem. [2]* 53, 484-500. Unsaturated Sulfones of the Naphthalene Series. Formed allyl β -naphthylsulfone by heating β -naphthylsulfinate with excess allyl bromide. Studied reaction.

95 Troeger, J., and Hinze, A. B.A. 1897, i, 350. *J. prakt. Chem. [2]* 55, 202-17. Addition of Halogens and Halogen Acids to Unsaturated Sulfones. Unsaturated sulfones were of the type $R \cdot SO_2 \cdot CH_2 \cdot CH:CH_2$ and were obtained by the action of allyl bromide on sulfonates. Absorb chlorine and bromine, but not iodine. Unite with HI or HBr but not HCl. See original for details.

96 Troeger, J., and Bolm, F. B.A. 1897, i, 536. *J. prakt. Chem. [2]* 55, 398-416. Sulfoketones of the Naphthalene Series. Prepared by heating chloracetone and naphthalenesulfinate in aqueous alcoholic solution. See abstract.

97 Troeger, J., and Uhde, R. B.A. 1899, i, 606. *J. prakt. Chem. [2]* 59, 320-49. Sulfonated Butyric Acids. Prepared by heating sodium arylsulfinate and ethyl α -bromobutyrate. When sodium salt of phenylsulfonebutyric acid is heated phenylpropylsulfone is produced. Others similar.

98 Troeger, J., and Hillie, W. B.A. 1903, i, 807. *J. prakt. Chem. [2]* 68, 309-12. m-Xylylallylsulfone. Discusses physical characteristics. Combines with Cl_2 or HBr. Prepared di-m-xylylethylene disulfone by the action of sodium m-xylylsulfinate and ethylene bromide.

99 Troeger, J., and Meine, W. B.A. 1904, i, 29. *J. prakt. Chem. [2]* 68, 313-40. Aromatic Disulfinic Acids. Aromatic disulfinic acids are more easily soluble in water, less soluble in ether, and have less tendency to crystallize than the monosulfide acids. See abstracts for details.

100 Ullmann, F., and Pasdermadjian, G. B.A. 1901, i, 383. *Ber. 34*, 1150-6. New Synthesis of Aromatic Sulfones. Aromatic sulfinic acids react readily with alcoholic solutions of halogen derivatives of aromatic nitro-compounds, yielding diphenyl sulfone derivatives. In certain cases it is necessary to work under increased pressure and in presence of sodium acetate.

101 Ullmann, F., and Lehner, A. B.A. 1905, i, 289. *Ber. 38*, 729-42. Benzophenonesulfone.* Product formed from chlorobenzene and chlorosulfonic acid.

102 Ullmann, F., and Korselt, J. C.A. 1907, 1276. *Ber. 40*, 641-8. Dichlorodiphenylsulfone.

103 Walter, G. B.A. 1895, i, 85. *Ber. 1894*, 27, 3043-5. Polymeric Ethoxysulfone Ethylenesulfinic Lactone. See G. Walter (*B. A.* 1893, i, 459).

104 Walter, G. B.A. 1895, i, 85. *Ber. 27*, 3045-49. Some Derivatives of Ethoxymethylsulfone. See G. Walter (*B. A.* 1893, i, 459). Prepared chlor, primary and secondary amine and barium sulfate salt.

105 Willgerodt, C., and Waldeyer, O. B.A. 1899, i, 606. *J. prakt. Chem. [2]* 59, 194-7. Iodoso- and Iodoxy-compounds of Di-iododiphenylsulfone. Gives preparation.

106 Zehenter, J., and Fauser, E. C.A. 1928, 949. *J. prakt. Chem. 117*, 233-44. Dihydroxydiphenylsulfones or Hydroxysulfobenzides. Method of preparation of these compounds given.

107 Zorn, L., and Brunel, H. B.A. 1895, i, 287. *Compt. rend.* 119, 1224-6. Constitution of Aromatic Sulfones. Used sulfuric anhydride vapors and well-cooled hydrocarbon.

CROSS REFERENCES

Group 2—17, 18, 47, 48, 66, 110; **Group 3**—7, 45, 68; **Group 6**—7, 12; **Group 7**—13, 24, 28; **Group 8**—15, 31; **Group 10**—11, 12, 13, 14, 15, 17, 32, 37, 56, 57, 66, 82, 84, 111, 120, 124, 134, 148, 154, 155, 157, 158, 159, 160, 162, 165, 169, 175, 180, 181, 182, 197, 206, 220, 258, 259, 265, 267, 282, 292, 293, 306, 307, 310, 311, 312, 313, 314, 316, 317, 318, 319, 321, 349, 375, 387, 389, 403, 411, 426, 428, 431, 439, 441, 443; **Group 11**—4, 13, 23, 26, 27, 28, 29, 47; **Group 12**—8, 16, 37, 40, 41, 42, 44, 55, 61, 83, 94; **Group 13**—8, 9, 14, 15; **Group 14**—4, 8, 9, 10, 17, 18, 22, 25, 34, 42, 43, 61, 66, 74, 75, 86, 87, 93, 96, 98, 99, 103, 110, 111, 113, 115, 116, 117, 118, 120, 124, 125, 128, 130, 131, 133, 134, 137, 142, 143, 144, 162, 164, 174, 175, 195, 199, 203, 210, 215, 217, 219, 223; **Group 15**—4, 5, 6, 7, 8, 9, 11; **Group 16**—1, 2, 9, 10, 18, 24, 25, 26.

GROUP 18

THIOPHENES

1 **Angeli, A., and Ciamician, G. B.A.** 1891, 427. *Ber.* 24, 74-8. Oxidation Products of Brominated Thiophenes. Tetrabromothiophene when treated with HNO_3 , sp. gr. 1.52, loses its sulfur and a portion of its bromine and is converted into dibrommaleic acid. Tribromothiophene is converted a bromocitronic acid. Alpha tribromothiophene gives probably dibromoacetyl acrylic acid.

2 **Angeli, A. B.A.** 1891, 550. *Ber.* 24, 232-3. Action of Ethyl Oxalate on Acetothiophene. Acetothiophene unites with ethyl oxalate in presence of sodium ethoxide to form ethyl ester of acetothiopheneoxalic acid. With alc. KOH is resolved into acetothiophene and oxalic acid. Copper salt is formed. Yields compounds with aniline and phenylhydrazine.

3 **Angeli, A. B.A.** 1892, 154. *Gazz. chim. ital.* 21, 444-9. Ethyl Acetothiopheneoxalate. Part of this paper has appeared in *B.A.* 1891, 550.

4 **Ardagh, E. G. R., and Furber, C. M. C. A.** 1929, 2969. *J. Chem. Soc. Ind.* 48, 73-5T. Removal of Thiophene from Benzene and a New Method for the Preparation of Thiophene-free Benzene on a Laboratory Scale. By heating C_6H_6 containing thiophene with red HgO and stearic acid and distilling off the C_6H_6 , it was freed of the thiophene, and a Hg -stearic acid compound of thiophene remained.

5 **Auwers, K., and Bredt, T. V. B.A.** 1894, i, 444. *Ber.* 27, 1741-7. Dithienyls. Sodium salt of butane tetracarboxylic acid heated with phosphorus trisulfide yields β , β -dithienyl, m.p. 132°. Sparingly soluble in glacial acetic acid and light petroleum, more rapidly in other solvents. Gives isatin test. Forms brom derivatives. Discussed α , α and β , β -dithienyls.

6 **Babasinian, V. S. C. A.** 1928, 4524. *J. Am. Chem. Soc.* 50, 2748-53. Mono-nitro- and Dinitro-thiophenes. Detailed directions are given for the nitration of thiophene. The properties of the above compounds are given.

7 **Baker, R. B., and Reid, E. E. C. A.** 1929, 2969. *J. Am. Chem. Soc.* 51, 1566-7. Action of Sulfur on Heptane and Butane. 40 g. heptane and 128 g. sulfur, when heated together at 300°-350° for 24 to 48 hours, give 2 g. of a thiophene of the formula $\text{C}_7\text{H}_10\text{S}$. C_4H_{10} gives thiophene.

8 **Baumann, E., and Fromm, E. B.A.** 1891, 1050. *Ber.* 24, 1441-56. Aromatic Thioaldehydes. Tri- and poly-thiobenzaldehydes yield cinnamene and thionessal on heating.

9 **Benary, E., and Silberstrom, L. C. A.** 1920, 1339. *Ber.* 52B, 1605-13. Synthesis of Thiophene Derivatives from β -Aminocrotonic Ester, II.*

10 **Bidet, A. B.A.** 1889, 595. *Compt. rend.* 108, 520-2. Effect of Thiophene and its Homologs on the Color of the Derivatives of Benzene and its Homologs. Benzene derivatives turn dark quicker due to thiophene.

11 **Biedermann, A. B.A.** 1886, 536. *Ber.* 19, 636-40. β -Thiophenealdehyde and β -Thienylalcohol. Gives method of preparations. β -Thiophenealdehyde in alkali gives alcohol and acid.

12 **Biedermann, A. B.A.** 1886, 870. *Ber.* 19, 1853-7. Thiophenealdehyde. See *B.A.* 1885, 764; 1886, 536. Shows close analogy to benzaldehyde. Prepared oxime and thiencylacrylic acid.

13 **Biedermann, A., and Jacobsen, P. B.A.** 1886, 1032. *Ber.* 19, 2444-7. Thiopene. This bears the same relation to thiophene as naphthalene does to benzene.

14 **Boedeker, E. B.A.** 1897, i, 25. *Compt. rend.* 123, 310-1. Action of Aluminum Chloride on Benzene Containing Thiophene. When ordinary benzene is boiled with AlCl_3 , H_2S is liberated and the thiophene is decomposed, one of the products being high boiling. It is probable that the thiophene residue after elimination of sulfur combines with the residues of 2 molecules of benzene from which hydrogen has been eliminated. A condensed thiophene may be formed at the same time, as Hauer has supposed.

15 **Bonz, R. B.A.** 1885, 766. *Ber.* 18, 549-52. Derivatives of β -Ethylthiophene. Prepared dibrom-, tribrom-, dichloro-, monoiodo-, and dinitro- β -ethyl thiophenes.

16 **Bonz, R. B.A.** 1885, 1206. *Ber.* 18, 2308-15. Bromination of α - and β -Thiophenic Acids. Compares known thiophenic acids by forming dibromides and then studying their properties, crystalline form, etc. Showed unexpected variations.

17 **Bonz, R. B.A.** 1885, 1207. *Ber.* 18, 2305-7. Synthesis of Thiophenedicarboxylic Acid. Dibromothiophene with ethylchlorocarbonate and sodium amalgam yields β -thiophenic acid and a thiophene dicarboxylic acid, identical with that obtained by Jaekel from thiophenedisulfonic acid and by Messinger from thioxylene (*B.A.* 1885, 767).

18 **Bradley, W. P. B.A.** 1886, 1014. *Ber.* 19, 2115-23. β -Thienylglyoxylic Acid and its Derivatives. Careful study of the preparation of this compound and some of its derivatives.

19 Brunck, K. *B. A.* 1893, i, 168. *Ann.* 272, 201-8. Thienylindole, α -Naphthylindole, and Some Bromo Derivatives of Indoles. Thienylindole is prepared and properties given.

20 Brunswig, H. *B. A.* 1887, 236. *Ber.* 19, 2890-6. Derivatives of Acetothiophene. Bromacetothiophene prepared by bromination in CS_2 . Vapors affect mucous membranes. Prepared the thiocyanate derivative. Cinnamyl thienyl ketone also prepared from acetothiophene and benzaldehyde.

21 Capelle, G. *C. A.* 1908, 1562. *Bull. soc. chim.* [4] 3, 154-5. Dibromthiophene. 2 g. of thiophene in CS_2 treated with 9 g. Br_2 in CS_2 and allowed to stand 24 hours. Heated, solvent distilled off, washed with KOH. Recrystallized from alcohol, m. p. 122.5°. Distills without decomposition.

22 Challenger, F., Haslam, J., Bramhall, R. J., and Walkden, J. *C. A.* 1926, 3231. *Petroleum Times*, 15, 289-90; 513-6. The Sulfur Compounds in Kimmeridge Shale Oil. An investigation was conducted to determine the sulfur compounds in that portion of Kimmeridge shale oil which is volatile with steam. Thiophene and its derivatives may be expected in shale oils which contain sulfur.

23 Chrzaszczewska, A. *C. A.* 1926, 1078. *Roczniki Chem.* 5 (1-3), 33-76. The Thiophenes and Intermediate Products for their Synthesis. Various thiophene derivatives are synthesized by Paal's method from salts of homologs of succinic acid.

24 Ciamician, G. *B. A.* 1889, 387. *Ber.* 22, 27-30. Physical Properties of Benzene and Thiophene. The constitution of the C_4H_4 group in thiophene molecule is similar to that of the same group in benzene.

25 Ciamician, G., and Angeli, A. *B. A.* 1891, 893. *Ber.* 24, 1347-51. Oxidation Products of Brominated Thiophenes. Continuation of work of *B. A.* 1891, 427. Structure of thiophene, pyrrole, and furan discussed.

26 Ciusa, R. *C. A.* 1923, 1466. *Gazz. chim. ital.* 52 (2), 130-1. Graphite from Pyrrole and from Thiophene. Preliminary Note.*

27 Comey, A. *B. A.* 1884, 1168. *Ber.* 17, 790-1. Phenyl Thienyl Ketone. Crude thiophene was heated with benzoyl chloride. The oxime melts 91°-92°. On distillation with soda lime calcium benzoate free from sulfur is obtained. Ketone gives blue color with isatin and the oxime a violet coloration.

28 Courtot, C., and Pomonis, C. *C. A.* 1926, 2155. *Compt. rend.* 182, 893-5. Diphenylene Sulfide Series.*

29 Curtius, T., and Thyssen, A. *B. A.* 1902, i, 304. *J. prakt. Chem.* [2] 65, 1-19. Hydrazides and Azoimides of Organic Acids. XXV, Hydrazide (and Azoimide) of α -Thiophenecarboxylic Acid.*

30 Damsky, A. *B. A.* 1887, 237. *Ber.* 19, 3282-6. Isomerism of the Thienophenic Acids. Derivatives of β -Thienophenic Acid. Studied yields in preparation of β -thienophenic acid and thiotolene. Prepared β -ethyli thiophene.

31 Demuth, R. *B. A.* 1886, 228. *Ber.* 18, 3024-6. Methylacetothiophene. Prepared by the action of aluminum chloride on β -thiotolene and acetic chloride dissolved in light petroleum. Reacts with hydroxylamine, and phenylhydrazine and sodium acetate. Can be nitrated. Studied derivatives formed.

32 Demuth, R. *B. A.* 1886, 871. *Ber.* 19, 1857-9. A Second Thioxylene. On dimethylthiophene.

33 Demuth, R. *B. A.* 1886, 871. *Ber.* 19, 1859-61. Methylacetothiophene. Prepared derivatives. See Demuth (*B. A.* 1886, 228).

34 Demuth, R. *B. A.* 1888, 538. *Ber.* 19, 679-88. Acetyl- and Carboxyl-derivatives of Thiophene. Studied oxidation of side chains on thiophene. Tried to prepare dicarboxylic acid.

35 Deniges, G. *B. A.* 1895, ii, 332; 1895, i, 411. *Compt. rend.* 120, 628-30. Mercuric Compound of Thiophene. Estimation of Thiophene in Benzene. Reagent used is 50 g. HgO in 200 cc. sulfuric acid diluted with 1000 cc. water. Warm solution with substance to be tested. Thiophene combines readily with Hg acetate, sulfate, or chloride in acid solution.

36 Deniges, G. *B. A.* 1895, ii, 372. *Compt. rend.* 120, 781-3. Estimation of Thiophene in Benzene. 2 cc. of benzene is dissolved in 30 cc. methyl alcohol free from acetone and 10 cc. of mercury solution (HgO 50 parts, sulfuric acid 200 parts, water 1000 parts) is added rapidly. Mixture agitated. After 20 minutes the precipitate is washed with boiling water and weighed. To find thiophene multiply by 0.1034.

37 Dimroth, O. *B. A.* 1899, i, 428. *Ber.* 32, 758-65. Action of Mercuric Salts on Aromatic Compounds. Thiophene can be separated from benzene by the action of mercuric sulfate, nitrate, or acetate; in the latter case chief product is thiophene dimercuric hydroxyacetate. HCl decomposes it into thiophene and HgCl_2 . See *B. A.* 1899, i, 54.

38 Domracheva, E. C. A. 1915, 1754. *J. Russ. Phys. Chem. Soc.* 46, 864-7. Action of Ethylmagnesium Iodide on α -Thienylethylketone. Latter obtained by action EtCOCl on thiophene in presence of AlCl_3 , yield 60%. EtMgI in Et_2O reacts with latter giving diethyl α -thienyl carbinol. Latter loses water at 120°, yielding methylethylthienylethylene.

39 **Douglas, P. B.A.** 1892, 831. *Ber.* 25, 1311-4. Nitrogenous Derivatives of Thiophene and Furfuran.
Prepared thiophene nitrile and some derivatives of it.

40 **Dziewonski, D., and Prokepczuk, M. C.A.** 1924, 983. *I. Zjazd. Chemikow Polskich*, 1923, 56. Dinaphthothiophene. I, The Action of Sulfuric Acid on Dinaphthothiophene.
The sulfonation reaction is one of extreme complexity. Many products obtained, intensely colored substances which have properties of dyeing animal fibers without use of mordants.

41 **Eberhard, O. B.A.** 1895, i, 23. *Ber.* 17, 2919. α , α -Dithienyl.
Prepared by heating α -iodothiophene with silver. It is not formed when α -bromo- or α -iodo-thiophene is treated with sodium in presence of ether or when iodo derivative is heated with a zinc dust. Ag must be prepared by means of an alkaline solution of glucose.

42 **Egli, K. B.A.** 1885, 766. *Ber.* 18, 544-9. Isomeric Thiotolenes (Methyl Thiophenes).
Thiotolenes obtained by v. Meyer and H. Kreis (B.A. 1884, 113 and 1132) are isomeric and not identical. See abstract.

43 **Ernst, F. B.A.** 1887, 237. *Ber.* 19, 3274-8. Reduction of α , α -Thiophene-dicarboxylic Acid.
Reduced by sodium amalgam (4%) to tetrahydrothiophenedicarboxylic acid.

44 **Ernst, F. B.A.** 1887, 238. *Ber.* 19, 3278-82. Synthetical Investigations in the Thiophene Series.
Attempted to prepare an anthracene of the thiophene series but no success. Prepared orthotolylthiienylketone, phenylthiienylketone, thietylglycolic acid, and thietylacetic acid.

45 **Ernst, F. B.A.** 1887, 471. *Ber.* 20, 518-20. Reduction of α -Thiophenic Acid.
 α -Thiophenic acid sole product of the oxidation of propiothiophene. Reduced by sodium amalgam forms tetrahydro α -thiophene-carboxylic acid. Prepared salts of this acid.

46 **Finzi, C. C.A.** 1916, 1639. *Gazz. chim. ital.* 45 (2), 280-90. Arsenical Acid Derivatives of Thiophene.*

47 **Finzi, C. C.A.** 1926, 1406. *Gazz. chim. ital.* 55, 824-34. Arsenical Derivatives of Thiophene, III.*

48 **Friedburg, L. H. B.A.** 1890, 1400. *J. Am. Chem. Soc.* 12, 83-90. Preparation of Thiophene.
Heat not more than 155 g. of sodium succinate and twice its weight of phosphorus trisulfide, 50% yield.

49 **Fromm, E., Fantl, P., and Leibsohn, E. C.A.** 1927, 3903. *Ann.* 457, 267-77. Diphenylthiophene.
 α , α' - and α , β -diphenylthiophenes and their derivatives given.

50 **Gattermann, L., Kaiser, A., and Meyer, V. B.A.** 1886, 227. *Ber.* 18, 3005-12. Constitutional Formula of Thiophene.
Experiments remove the objections to V. Meyer's formula for thiophene showing there are only two series of derivatives. The third series was a mixture of the other two. See abstract or original.

51 **Gattermann, L. B.A.** 1886, 228. *Ber.* 18, 3012-5. α - and β -Thienone.
 β -Thienone prepared from carbonyl chloride and thiophene with aluminum chloride in light petroleum. Also obtained by distilling β -thiophenone. α -Thienone is prepared by distilling α -thiophenone.

52 **Gattermann, L., and Romer, M. B.A.** 1886, 537. *Ber.* 19, 688-95. Action of Acetic Chloride on Halogen Derivatives of Thiophene.
Acetylchloride and dibromothiophene in petroleum ether with $AlCl_3$ form bromoacetothiophene. Derivatives of thienones prepared.

53 **Gerlach, M. B.A.** 1892, 829. *Ann.* 267, 145-72. β -Ethylthiophene and Thiophene α , β -Dicarboxylic Acid.
Prepared β -ethylthiophene by distilling a mixture of anhydrous sodium ethylsuccinate and phosphorus trisulfide. See abstract for other derivatives.

54 **Goldschmidt, H., and Schulthess, W. B.A.** 1887, 718. *Ber.* 20, 1700-1. Thienethylamine.
Acetothiophene is converted on hydrogenation into thienethylamine. It absorbs carbon dioxide from the air. Forms benzoyl and acetyl derivatives.

55 **Goldschmidt, H., and Zanolli, E. B.A.** 1892, 1443. *Ber.* 25, 2573-96. Oximes of Furfuraldehyde, Thiophenealdehyde and Oenanthaldehyde.
See abstract concerning oximes formed.

56 **Gomberg, M., and Jickling, R. L. C.A.** 1913, 2043. *J. Am. Chem. Soc.* 35, 446-7. Thiophene Analogs of Triphenylethyl.
A preliminary note on its preparation and properties.

57 **Grimaldi, G. P. B.A.** 1886, 613. *Gazz. chim. ital.* 16, 63-4. Physical Properties of Thiophene.
See abstract or original.

58 **Grishkevich-Trokhimovskii, E. C.A.** 1912, 223. *J. Russ. Phys. Chem. Soc.* 43, 201-3. Action of Thienyl Magnesium Iodide on Allyl Bromide.
 α -Allylthiophene formed from above products. Its action with Br , liquid NO_2 , phenanthraquinone, isatin, $KMnO_4$ and HNO_3 given.

59 **Grishkevich-Trokhimovskii, E. C.A.** 1912, 223. *J. Russ. Phys. Chem. Soc.* 43, 204-7. Preparation of α -Thiophenealdehyde and its Derivatives.
Thiophenealacetal obtained by action of Mg and Et formate on α -iodothiophene. Upon saponification with dilute HCl in current of CO_2 yields α -thiophenealdehyde.

60 **Grishkevich-Trokhimovskii, E., and Matzrevich, I. C.A.** 1912, 2406. *J. Russ. Phys. Chem. Soc.* 44, 570-81.

Transformations of α -Thiophenealdehyde.
For various reactions see abstract.

61 Grunewald, W. *B. A.* 1888, 48. *Ber.* 20, 2585-7. Orthothioxene- and Orthothiophene-dicarboxylic acid.
Gives preparation.

62 Haller, A., and Michel, E. *B. A.* 1897, i, 513. *Bull. soc. chim.* [3] 15, 1065-70. Purification of Hydrocarbons from Thiophene, its Homologs and other Impurities By Means of Aluminum Chloride. Application to the Purification of Benzene and Toluene. Best results with benzene—not so good with toluene. See work of Heusler on this method.

63 Hantzsch, A. *B. A.* 1886, 1014. *Ber.* 19, 2400-2. Action of Phosphoric Sulfide on Complex Furfurane Derivatives.
Attempt to convert furfurane derivatives into thiophene derivatives. See abstract.

64 Hantzsch, A., and Freese, H. *B. A.* 1894, i, 572. *Ber.* 27, 2529-34. Color Reactions of Certain Sulfur Compounds Which Occur With Aniline Bases.
Suggests presence of amidothiophene in aniline, as there is present 0.2 to 0.04 per cent sulfur. Suggests best method of purification of aniline is boiling it for some time with acetone.

65 Hantzsch, A., and Freese, H. *B. A.* 1895, i, 24. *Ber.* 1894, 27, 2966-8. Sulfur in Aniline and Paramidophenol and the Calcium Hypochlorite Reaction.
See same authors (*B. A.* 1894, i, 572). Seems to be a connection between the browning of aniline and the sulfur which it contains.

66 Hantzsch, A., and Witz, R. *B. A.* 1901, i, 401. *Ber.* 34, 841-7. Anils of Thiophenealdehyde.
Thiophene aldehyde and aromatic amines react to give 2 isomers except for phenyl, p-toluidine, and p-bromaniline.

67 Hartley, H., and Thomas, N. G. *J. Chem. Soc. Trans.* 1906, 1022-3. Solubility of Triphenylmethane in Organic Liquids With Which It Forms Crystalline Compounds.
Solubility in thiophene.

68 Heusler, F. *B. A.* 1897, i, 402. *Z. anorg. Chem.* 9, 750. Removal of Thiophene from Benzene by Means of Aluminum Chloride.
Reflux for 9 hours with 5% AlCl_3 , and then distill without decantation. Better product this way.

69 Hinsberg, O. *C. A.* 1913, 85. *Ber.* 45, 2413-8. Thiophene and Furane Derivatives.
Thiophenedicarboxylic acid, triethyl 3-hydroxythiophene 2, 4, 5-tricarboxylate, methyl 3, 4-dihydroxythiophene 2-carboxylate and certain furane derivatives given.

70 Holleman, A. F., and Voerman, G. L. *B. A.* 1907, i, 334. *Proc. K. Akad. Wetensch. (Amsterdam)* 9, 514-24. Thiophene 2- and 3-carboxylic Acids. Preparations given.

71 Jaekel, H. *B. A.* 1886, 339. *Ber.* 19, 184-96. Thiophenedisulfonic Acid.
Prepared by sulfonating lead salt of thiophenesulfonic acid. Fused with KCN forms dicyanide.

72 Jaekel, H. *B. A.* 1886, 613. *Ber.* 19, 1066-7. Thiophenedisulfonic Acid.
Copper and silver salts prepared.

73 Jaffe, M., and Levy, H. *B. A.* 1889, 239. *Ber.* 21, 3458-61. Glycocene-derivative of α -Thiophenic Acid.
Preparations and toxic effects studied.

74 Keiser, K. *B. A.* 1895, i, 508. *Ber.* 28, 1804-7. Ortho Substitution Products in the Thiophene Series.
Treated dimethyl thiophene from coal tar with AlCl_3 and acetyl chloride to form acetyl derivative, then with bromine to form monobromo derivative thus having all positions substituted.

75 Keiser, K. *B. A.* 1897, i, 24. *Ber.* 29, 2560-4. Coal Tar Thioxene (Dimethylthiophene).
Gives method of purification of 2, 5-dimethylthiophene.

76 Kitt, M. *B. A.* 1895, i, 509. *Ber.* 28, 1807-14. Dimethylthiophene (Thioxene).
2, 5-Dimethylthiophene was prepared from acetonylacetone and phosphorus pentasulfide. Occurs in coal-tar.

77 Kopp, K. *B. A.* 1892, 718. *Ber.* 25, 600-3. Substitution Products of Stilbene and Thionessal.
Studied methoxythiobenzaldehyde and heat. Prepared diorthomethoxystilbene and a substituted thionessal.

78 Krause, E., and Renwanz, G. *C. A.* 1928, 76. *Ber.* 60B, 1582-3. New Metal Derivatives of Thiophene. I, Tetra α -Thienyl Tin and Tetra α -Thienyl Lead.
Prepared from thiophene magnesium iodide and the corresponding metal chloride.

79 Krause, E., and Renwanz, G. *C. A.* 1929, 4698. *Ber.* 62B, 1710-6. New Metallic Derivatives of Thiophene. II, Thallium, Silicon, Bismuth, Tellurium, and Mixed Tin and Lead Thienyls.
Preparation and properties of these compounds given.

80 Kreis, H. *B. A.* 1884, 1314. *Ber.* 18, 2073-5. Nitration of Thiophene-derivatives.
Prepared iodonitrothiophene and dibromonitrothiophene.

81 Kreis, H. *B. A.* 1902, ii, 535. *Chem. Ztg.* 26, 523. A New Color Reaction of Thiophene.
A solution of thiophene in benzene or light hydrocarbon is shaken with 2 volumes of nitric acid of sp. gr. 1.4 and a

trace of p-methoxytetrahydroquinoline (thallin base). Assumes the color of methyl-violet which disappears on dilution.

82 Krekeler, K. B.A. 1886, 538. Ber. 19, 674-9. Isobutyrothienone and Propiethienone.
Use of AlCl_3 and acid chloride. Oximes prepared. Prepared sulfonic acids.

83 Krekeler, K. B.A. 1887, 141. Ber. 19, 2623-8. Action of Sulfuric Acid on Aromatic Ketones.
Prepared $\text{CHMe}_2 \cdot \text{CO} \cdot \text{C}_4\text{SH}_2 \cdot \text{SO}_3\text{H}$ by the action of pyrosulfuric acid in the cold on thienone. Forms phenylhydrazine derivative.

84 Krekeler, K. B.A. 1887, 239. Ber. 19, 3266-74. Pentathiophene Group.
Prepared β -methylpentathiophene from sodium methyl glutarate. See abstract.

85 Kues, W., and Paal, C. B.A. 1886, 536. Ber. 19, 555-7. Synthesis of Thiotenol (Hydroxythiophene) and Thiotolene.
Thiotenol ($\text{C}_4\text{H}_8\text{SMeOH}$) is prepared in 30% yield from levulinic acid and phosphorus pentasulfide. Thiotolene is prepared from 1 part levulinic acid and 1.5 parts of phosphorus trisulfide.

86 Kues, W., and Paal, C. B.A. 1887, 238. Ber. 19, 3141-4. Synthesis of α -Phenylthiophene.
Gives method of synthesis from δ -benzoisuccinic or other acids. Has odor of diphenyl. Prepared derivatives with bromine. Very stable.

87 Lanfry, M. C.A. 1911, 1590. Compt. rend. 152, 92-4. New Thiophene Compound, $\text{C}_{10}\text{H}_8\text{S}_2$, and Some Derivatives.
Naphthalene and sulfur react at a high temperature giving a phenothiophene, m.p. 118°. Oxidized to $\text{C}_{10}\text{H}_8\text{O}_2\text{S}_2$, m.p. 130°, and $\text{C}_{10}\text{H}_8\text{O}_3\text{S}$, m.p. 125°. Tetrabromide and nitro-derivatives given.

88 Lanfry, M. C.A. 6, 619. Compt. rend. 153, 821-3. Oxy β -methylthiophenes.
Action of H_2O_2 on above substance same as on thiophene. With 1.4 and 2.5 parts O_2 are obtained dioxy β -methylthiophene and tetraoxythiophene respectively. Action of Br given.

89 Lanfry, M. C.A. 1912, 1748. Compt. rend. 154, 1090-2. Action of Hydrogen Peroxide on Bromothiophenes.
Monobromothiophene is decomposed with small quantities of H_2O_2 liberating part of the Br and forming the dibromo derivatives. The dibrom compound is decomposed similarly. The tri- and tetra-bromides are not attacked by H_2O_2 .

90 Lanfry, M. C.A. 1912, 2740. Compt. rend. 155, 170-2. Action of Hydrogen Peroxide on Acetothiophene and α -Thiophencarboxylic Acid.
Former destroyed to extent of 15.2% by boiling 30 min. in dil. AcOH with H_2O_2 . Latter is 3.4% destroyed by boiling 1 hour.

91 Lanfry, M. C.A. 1913, 767. Compt. rend. 155, 836-8. Action of Hydrogen Peroxide on Trithienyl.
Above compounds in dilute AcOH solution give $\text{C}_{12}\text{H}_8\text{S}_2\text{O}_2$ and $\text{C}_{12}\text{H}_8\text{S}_2\text{O}_4$.

92 Langer, J. B.A. 1884, 1133. Ber. 17, 1566-70. Isomeric Thiophenesulfonic Acids.
Prepared bromothiophenesulfonic acids. See V. Meyer and H. Kreis (Ber. 17, 1558-63; B.A. 1884, 1131).

93 Langer, J. B.A. 1885, 765. Ber. 18, 553-63. Isomeric Thiophenesulfonic Acids. (Continuation of Previous Work B.A. 1884, 1133).
Prepared thiophenesulfonic acids and substituted acids. See abstract.

94 Langer, J. B.A. 1885, 887. Ber. 18, 1114-6. Isomeric Thiophenesulfonic Acids. (Continued from B.A. 1884, 1133).
Attempted to prepare iodothiophenesulfonic acids, but products were not purified.

95 Leko, M. T. B.A. 1887, 471. Chem. Zentr. 1887, 41. Thiophene in Aniline.
Tested commercial aniline with phenylhydrazine and results were negative.

96 Levi, S. B.A. 1886, 539. Ber. 19, 656-9. Isomeric Thiotolinic Acids.
Methyl and carboxyl substituted thiophene prepared.

97 Levi, L. E. B.A. 1886, 787. Ber. 19, 1623-5. Diphenylthienylmethane.
Benzhydrole and thiophene with excess of phosphoric anhydride react readily. On nitration thiophene group splits off. Friedel and Craft's reaction form acetyl derivative on thiophene group.

98 Levi, L. E. B.A. 1887, 481. Ber. 20, 513-7. Thiophene Green.
Replaced the phenyl group with thietyl in leucobase of malachite green. Prepared the dye.

99 Levi, L. E. B.A. 1891, 551. Chem. Zentr. 1890, ii, 949-50. Tech. Quart. 3, No. 2. Biophene.
Phosphorus trisulfide on thiodiglycolic acid gives biophene $\text{C}_4\text{H}_8\text{S}_2$, similar to thiophene. Gives color test with isatin. Gives reaction products with aluminum chloride, acid chlorides, and nitrates.

100 Liebermann, C. B.A. 1888, 325. Ber. 20, 3231-4. Thiophene Reaction with Nitrous Sulfuric Acid. (See Ber. 16, 1473.)
Two or three drops of H_2SO_4 containing nitrous acid are shaken with 1 cc. of benzene to be examined. Acid gradually acquires corn-flower-blue color. With 2% to 3% thiophene, the color change occurs in a few minutes, with small amounts, in 10 to 15 minutes. Can detect 0.25 mg. thiophene. Must have continued shaking for oxygen of the air seems to play some part in it.

101 Liebermann, C. B.A. 1893, i, 406. Ber. 26, 853-4. Thiophene of Crystallization.
Triphenylmethane and dibromo β -dianaphthoxydine crystallize with one molecule of thiophene to form transparent colorless crystals that lose thiophene in air and become opaque. α -Truxillic acid chloride also forms thiophene compound.

102 Liebermann, C., and Pleus, B. B.A. 1904, i, 684. Ber. 37, 2461-4. The

Thiophene Reaction with Nitrous Sulfuric Acid.

Nitrous sulfuric acid test fails at 0.1% while isatin test is good for 0.01%. Using Dimroth's method (*B. A.* 1899, i, 428) benzene contained 0.077% thiophene. The indophenine reaction is obtained with pure sulfuric acid free from nitrogen.

103 Marcusson, J. *B. A.* 1894, i, 16. *Ber.* 26, 2457-65. The Thiophene Group.
The author has been unable to obtain thiophene derivatives having a halogen or nitro group in the ortho position to a carbonyl group. Phenylthienylketone is most easily obtained by exposing a mixture of thiophene, $AlCl_3$ and excess benzoyl chloride to direct sunlight, b. p. 300° , solidifies in needles. See abstract or original for action of bromine and nitric acid on the ketone.

104 Messinger, J. *B. A.* 1885, 767. *Ber.* 18, 563-8. Thioxylene from Coal Tar.
Isolated thioxylene from coal tar. Prepared from derivative and dicarboxylic acid.

105 Messinger, J. *B. A.* 1885, 1052. *Ber.* 18, 1636-40. Thioxylene from Coal Tar.
Method of separation and purification from coal tar given. Prepared mono-, bromo-, iodo-, and nitro-thioxylene as well as methyl and ethyl thiophenedicarboxylate.

106 Messinger, J. *B. A.* 1885, 1205. *Ber.* 18, 2300-3. Thioxylene from Coal Tar.
Thioxylene with $AlCl_3$ and acetyl chloride yields acetothioxylene. Forms oxime. Oxidation with permanganate gives tricarboxylate. Methyl ester melts at 118° .

107 Meyer, V. *B. A.* 1883, 1091. *Ber.* 16, 1465-78. Thiophene, a Substance Contained in Coal Tar Benzene.
Outlines method of obtaining thiophene from benzene. Gives two mono substitution products. Thiophene is the cause of the color test with isatin.

108 Meyer, V., and Kreis, H. *B. A.* 1884, 45. *Ber.* 16, 2172-6. The Thiophene Group.
Tetrabromothiophene, thiophene sulfonic acid, and thiophenenitrile react to form thiophenic acid. Authors note the presence of a sulfur compound in purest toluene of commerce.

109 Meyer, V. *B. A.* 1884, 586. *Ber.* 16, 2968-75. The Thiophene and Pyrroline Groups.
Outlines work planned. Calls C_4H_8S , thietyl. See abstract concerning homologs, the sulfonic acid of thiophene.

110 Meyer, V., and Kreis, H. *B. A.* 1884, 1131. *Ber.* 17, 1558-63. Homologs of Thiophene.
Prepared iodine and alkyl derivatives. All show Laubenheimer's reaction. See abstract.

111 Meyer, V. *B. A.* 1884, 1131. *Ber.* 17, 1563-6. Isomerism in the Thiophene Series.
If formula proposed by V. Meyer is correct, then only 2 isomers can be prepared. Gives experimental evidence.

112 Meyer, V., and Kreis, H. *B. A.* 1884, 1132. *Ber.* 17, 787-9. Substances Accompanying Toluene in Coal Tar.
See *B. A.* 1883, 1092 and 1884, 586. Isolated thiotoluene or methylthiophene from toluene as the tribromide.

113 Meyer, V. *B. A.* 1885, 141. *Ber.* 17, 2641-3. Preparation of Pure Thiophene.
Extracting thiophene from benzene by use of H_2SO_4 . Distil the sulfonic acid.

114 Meyer, V., and Stadler, O. *B. A.* 1885, 141. *Ber.* 17, 2648-50. Nitration of Thiophene.
Mono and dinitro derivates formed. Dinitro derivative gives no reaction with isatin and H_2SO_4 . Constants given.

115 Meyer, V., and Stadler, O. *B. A.* 1885, 250. *Ber.* 17, 2778-9. The Thiophene Group.
Endeavored to obtain amido derivatives of thiophene. Results negative. Studied color obtained with alkali on nitrothiophenes.

116 Meyer, V. *B. A.* 1885, 763. *Ber.* 18, 526-9. Constitution of Thiophene Compounds.
Discussion of constitution and what researches are most likely to finally prove its correctness.

117 Meyer, V. *B. A.* 1885, 887. *Ber.* 18, 1326-30. Thiotolene and Thiophene.
Theoretical, see original.

118 Meyer, V., and Stadler, O. *B. A.* 1885, 971. *Ber.* 18, 1488-90. Direct Preparation of Dibromothiophene from Coal Tar Benzene.
Brominate thiophene in benzene and distill off benzene. B. p. dibrom, $203^\circ-207^\circ$; monobrom, $149^\circ-151^\circ$.

119 Meyer, V. *B. A.* 1885, 1051. *Ber.* 18, 1770-3. The Thiophene Group.
Theoretical discussion. States that nitrothiophene is a very violent poison.

120 Meyer, V. *B. A.* 1885, 1207. *Ber.* 18, 2315-6. Remarks on Preceding Paper (of R. Bonz, *Ber.* 18, 2308-15).
Unexpected results in comparison of α - and β -thiophenic acids. May be due to accidental impurities too small to be noted on analysis. Will continue research on this subject.

121 Meyer, V. *B. A.* 1886, 713. *Ber.* 19, 1432. Thionaphthene.
Prepared from thiophenealdehyde and succinic acid.

122 Meyer, V. *B. A.* 1887, 129. *Ann.* 236, 200-4. Relation of the So-called α -Thiophenic Acid to the Normal Thiophenecarboxylic Acids.
The so-called α -acid is really a mixture of α - and β -acids which cannot be separated by recrystallization.

123 Meyer, V. *B. A.* 1887, 572. *Ber.* 20, 534-6. Negative Nature of the Phenyl Group.
The thietyl group exerts an influence in the molecule similar to that of phenyl.

124 Minnuni, G. B.A. 1891, 1342. *Gazz. chim. ital.* 21, 143-8. Thiophene.
Discusses purification of thiophene with phenylhydrazine.

125 Muhlert, F. B.A. 1886, 229. *Ber.* 18, 3003-5. γ -Thiophenic Acid.
Oxide thiotolene, V. Meyer (B.A. 1885, 1051). Ag salt sparingly soluble in water. Nitric acid on γ -tribromothiophene forms dinitro compound.

126 Muhlert, F. B.A. 1886, 535. *Ber.* 19, 633-6. Diethylthiophene.
Prepared brom, nitro, and aceto derivatives from diethylthiophene.

127 Muhlert, F. B.A. 1886, 787. *Ber.* 19, 1620-3. Methylthiophene Sulfonic Acid.
Prepared by Krekeler's method (B.A. 1886, 538) from acetomethylthiophene. Aceto group replaced by sulfonic acid.

128 Nahke, A. B.A. 1897, i, 602. *Ber.* 30, 2041-3. Dithienylethane, Dithienylethylene, and the Condensation of Thiophene with Benzotrichloride and Aluminum Chloride.

Monochloracetal, chloroform, ether, thiophene, and phosphoric anhydride form dithienylchloroethane. Other dithienyl derivatives prepared.

129 Nahke, A. B.A. 1897, i, 603. *Ber.* 30, 2040. α -Dithienylethyl Methyl Ketone or Acetyl α -Dithienylethane.
Prepared by P_2O_5 , diacetyl and thiophene.

130 Nahke, A. B.A. 1897, i, 603. *Ber.* 30, 2033-7. Dithienylphenylmethane—Its Nitro, Amido, and Sulfonic Derivatives.
Gives improved method of purification with superheated steam and method of preparing derivatives.

131 Nahke, A. B.A. 1897, i, 60. *Ber.* 30, 2037-9. Condensation of Iodothiophene with Benzaldehyde and of Thiophene with Different Aldehydes.
Gives detailed method of condensing thiophene with aldehydes. See abstract.

132 Nahnsen, R. B.A. 1884, 1132. *Ber.* 17, 789-90. Dithienyl.
Pass thiophene through red hot tube just to redness and dithienyl is formed. Gives test with isatin and sulfuric acid. Benzene and thiophene give a mixture with probably a phenylthiophene.

133 Nahnsen, R. B.A. 1885, 50. *Ber.* 17, 2197-8. The Thiophene Group.
Dithienyl studied more thoroughly. For preparation see previous work. Prepared sulfonate and perbromo derivatives.

134 Nahnsen, R. B.A. 1885, 51. *Ber.* 17, 2192-6. β -Thiophenic Acid.
Gives preparation, salts formed, acid chloride, and amide and nitro derivatives. Author gives method of preparation of acid and certain salts. The acid chloride, amide, and a nitro derivative are given.

135 Nahnsen, R. B.A. 1885, 1207. *Ber.* 18, 2304. Action of Ethyl Chlorocarbonate and Sodium Amalgam on Diiodothiophene.
Hoped to obtain thiophenedicarboxylic acid but only obtained β -thiophenic acid.

136 Nasini, R., and Scala, A. B.A. 1887, 754. *Gazz. chim. ital.* 17, 66-72. Molecular Refractive Energies of the Thio-cyanates and Thiocarbimides.
Measured methyl and ethyl thiocyanates, thiophene, and methyl, ethyl, allyl, and phenyl thiocarbimides.

137 Nasini, R., and Carrara, G. B.A. 1894, ii, 302. *Gazz. chim. ital.* 24, i, 256-90. Refraction Constants of Oxygen, Sulfur, and Nitrogen in Heterocyclic Nuclei.
Refraction constants for the rays H_a , β , γ , and D are given for thiophene and dimethylthiophene. Thiophene examined in benzene solution.

138 Opolski, St. B.A. 1905, i, 367. *Bull. Acad. Sci. (Cracow)* 1904, 727-32. Influence of Light and Heat on the Chlorination and Bromination of Homologs of Thiophene.
 Cl_2 or Br_2 in sunlight on 2-methyl or 2-ethyl thiophene gives substitution in ring—very little side chain. See abstract.

139 Opolski, St. B.A. 1906, i, 33. *Bull. Acad. Sci. (Cracow)* 1905, 548-57. Influence of Light and Heat on the Chlorination and Bromination of Homologs of Thiophene.
Reports on experiments of chlorination of alkyl thiophenes. Some of the halogenated derivatives give the color tests only indistinctly and with difficulty.

140 Ossipoff, I. B.A. 1889, 237. *J. Russ. Chem. Soc.* 20, 245-54. Action of Phosphorus Sulfides on Dibromosuccinic Acids.
Dibromosuccinic acid on treatment with phosphorus trisulfide or pentasulfide does not form thiophene compounds, but thiomalic acid.

141 Paal, C. B.A. 1885, 516. *Ber.* 18, 367-71. Synthesis of Thiophene and Pyrroline Derivatives.
2,5-Phenylmethylthiophene is obtained by heating acetophenoneacetone with phosphoric sulfide in sealed tubes for about 1 hour at 120°-130° C.

142 Paal, C., and Tafel, J. B.A. 1885, 763. *Ber.* 18, 688-9. Thiophene from Erythrite.
Thiophene is obtained in an impure state by distilling a mixture of erythrite, phosphorus pentasulfide, and sand.

143 Paal, C., and Tafel, J. B.A. 1885, 764. *Ber.* 18, 456-60. Thiophene from Mucic Acid.
Mixture of mucic acid with twice its weight of barium sulfide is heated in a closed tube for 6 hours at 200°-210°. Product probably α -thiophenic acid. This heated with lime gives thiophene.

144 Paal, C. B.A. 1885, 1205. *Ber.* 18, 2251-4. Synthesis of Thioxylene and Pyrroline Derivatives.
A thioxylene is prepared by heating acetyl acetone (B.A. 1885, 505) with finely powdered phosphorus pentasulfide in a reflux apparatus. Pure compound readily dissolves sulfur. Gives some color reactions. Prepared dibrom derivative and oxidized one methyl to carboxyl.

145 **Paal, C., and Puschel, A. B.A.** 1887, 1101. *Ber.* 20, 2557-60. 1,3-Methylphenylthiophene and 1,2-Thioxene. Gives preparation and some reactions.

146 **Paolini, V. B.A.** 1907, i, 788. *Gazz. chim. ital.* 37, i, 58-62. Thiophene. Studies reaction between thiophene and saturated mercuric acetate.

147 **Paolini and Silberman. C.A.** 1916, 580. *Rend. Accad. Lincei* 24, 209-11. Estimation of Thiophene in Benzene. Determined in the form of the tetra-mercury acetate.

148 **Pawlewski, B. B.A.** 1888, 1068. *Ber.* 21, 2141-2. Thiophene. Determination of vapor density at various temperatures, concludes no decomposition at 330°-340°. See R. Schiff (B.A. 1888, 971).

149 **Peter, A. B.A.** 1884, 1000-2. *Ber.* 17, 1341-7. Condensation Products of Thiophene with Aldehydes, Methylal and Benzyl Alcohol. Investigates the analogy between benzene and thiophene. Prepares various thiienyl methanes as well as thiienylchloroethylenes and ethane.

150 **Peter, A. B.A.** 1885, 141. *Ber.* 17, 2643-7. Acetothienone and Some of Its Derivatives. Prepared by action of aluminum trichloride on thiophene with acetyl chloride in petroleum ether. Forms oxime and phenylhydrazine derivative. Oxidized to thiophenic acid.

151 **Peter, A. B.A.** 1885, 764. *Ber.* 18, 537-42. β -Acetothienone and Its Derivatives. Acetothienone when carefully oxidized forms β -thienylglyoxylic acid. When heated in atmosphere of hydrogen yields β -thiophenealdehyde having an odor resembling benzaldehyde and furfuraldehyde. See abstract for other derivatives.

152 **Peter, A. B.A.** 1885, 765. *Ber.* 18, 542-4. Isomeric Thiophenic Acids. Compares his work with other published work. Prepared α - and β -acids.

153 **Purvis, J. E. C.A.** 1910, 3213. *Proc. Chem. Soc.* 97, 1648-59. Absorption Spectra of Furane, Furfuraldehyde, Thiophene, and Pyrrole under Different Conditions. Thiophene and pyrrole show a few bands, 2 of which are comparable with 2 in vapors of furane and furfuraldehyde. EtOH solutions of thiophene show no absorption bands.

154 **Rimini, E. B.A.** 1899, i, 872. *Chem. Ztg.* 23, 266. Acetylthiophenine (Acetamidothiophene). Acetylthiophene ketoxime is best rearranged as follows: dissolve in dry ether, cool in freezing mixture, add PCl_5 until reaction ceases, wash the ethereal solution with water and finally crystallize from alcohol. Product acetamidothiophene.

155 **Romer, M. B.A.** 1887, 362. *Ber.* 20, 116-8. Nitration of α -Thiophenic Acid. α -Thiophenic acid added gradually to concentrated nitric acid at 50° forms nitro α -thiophenic acid. Two modifications.

156 **Rosenberg, J. B.A.** 1885, 1051. *Ber.* 18, 1773-8. Tribromothiophene and Double Compounds of Dinitrothiophene. Prepared tribromo- and tribromo-sulfonic anhydride of thiophene. Prepared nitro derivatives.

157 **Rosenberg, J. B.A.** 1886, 228. *Ber.* 18, 3027-31. Derivatives of Brominated Thiophenes. Prepared tribromothiophene sulfochloro and tribromonitrothiophene. See H. Rosenberg (B.A. 1885, 1051).

158 **Rosenberg, J. B.A.** 1886, 534. *Ber.* 19, 650-2. Trichlorothiophene and Its Derivatives. Prepared trichloro, sulfonic, and nitro derivatives. Positions of chlorine not definite.

159 **Ruffi, H. B.A.** 1887, 804. *Ber.* 20, 1740-50. Normal Propylthiophene Derivatives. Glyoxylic Acids of the Thiophene Series. Oxidized the propyl group forming α -thiophenic acid. Prepared many other derivatives.

160 **Sachs, H. B.A.** 1892, 966. *Ber.* 25, 1514-8. Thiophenechlorophosphine and Its Derivatives. Prepared $\text{C}_4\text{H}_9\text{SPCl}_2$ with P in 2 positions, and derivatives.

161 **Salvatori, S. B.A.** 1892, 303. *Gazz. chim. ital.* 21, ii, 268-94. Derivatives of Ethyl Acetothienoneoxalate. Salts and nitrogen derivatives formed.

162 **Scheibler, H. C.A.** 1916, 340. *Ber.* 48, 1815-26. Chemical Constituents of the Bituminous Tar Oils Rich in Sulfur (Ichthyl Oils), I. Work done on a crude oil from southern France. Various reactions indicate presence of thiophene compounds. Attempts to isolate them gave little success.

163 **Scheibler, H. C.A.** 1917, 2673. *Ber.* 49, 2595-600. Chemical Constituents of Bituminous Tar Oils Rich in Sulfur (Ichthyl Oils), II. Connection between Scheibler's conclusions that ichthyl oils contain thiophene derivatives and Friedmann's recent discoveries that such compounds can be obtained by action of sulfur on straight chain hydrocarbon (C.A. 1917, 940) is discussed.

164 **Scheibler, H., and Schmidt, M. C.A.** 1921, 2091. *Ber.* 54B, 139-54. Thiophene Compounds. I, The Isomeric Propyl- and Isopropyl-thiophenes. The preparation of 2-isopropyl, and 2 propyl thiophene and certain derivatives are given.

165 **Scheibler, H. C.A.** 1927, 646. *Z. angew. Chem.* 39, 1397-8. Isolation and Identification of Thiophene Compounds in Shale Oils. A review (cf. C.A. 1926, 3005) 2-*n*-Bu-3-*n*-Pr-, and 2-*iso*-Pr-thiophene have been identified.

166 Scheibler, H., and Rettig, F. *C. A.* 1926, 3005. *Ber.* 59B, 1194-7. Thiophene Compounds, II. 3-butyl and 2-butyl thiophene and other derivatives are given.

167 Scheibler H., and Rettig, F. *C. A.* 1926, 3005. *Ber.* 59B, 1198-202. Chemical Constituents of Bituminous Petroleum Rich in Sulfur (Ichthyl Oils), IV. 2-butylthiophene, thiophene, and its propyl and isopropyl homologs were detected.

168 Schiff, R. *B. A.* 1885, 971. *Ber.* 18, 1601-5. Physical Properties of Thiophene. B. p. 83.9-84.2° (corr.) under 755.7 mm. Density and expansion coefficient given. Absolute critical temperature 576°. Molecular volume at the boiling point 84.93°.

169 Schleicher, E. *B. A.* 1886, 227. *Ber.* 18, 3015-23. Monobromothiophene and Ethylthiophene. See Schleicher (*B. A.* 1883, 1091). Prepared the following derivatives from β -ethylthiophene; ethylthiophenic acid, acetoethylthiophene, nitroacetoethylthiophene.

170 Schleicher, E. *B. A.* 1886, 534. *Ber.* 19, 671-2. Limited Oxidation of Ethylthiophene. On oxidation with small quantities of dilute permanganate yields β -thiophenic acid and a little acetothiophene.

171 Schleicher, E. *B. A.* 1886, 534. *Ber.* 19, 672-4. Isopropylthiophene. From Friedel and Craft's reaction. Intense odor. Reacts with phenanthraquinone in glacial acetic acid and sulfuric acid to give intense violet red color which disappears on diluting with water.

172 Schleicher, E. *B. A.* 1886, 539. *Ber.* 19, 660-70. Ketones of the Thiophene Group. Acetoneethylthiophene has a fruity odor when pure. Forms sulfonic acid. Prepared hexylthiienylketone and its oxime.

173 Schulze, K. E. *B. A.* 1885, 251. *Ber.* 17, 2852-4. A Simple Method of Obtaining Thiotolene and Thioxylene. Obtained by steam distilling acids used in purifying xylene and toluene.

174 Schulze, K. E. *B. A.* 1885, 763. *Ber.* 18, 497-8. Method of Obtaining Thiophene and its Homologs. Obtained from benzene and its homologs by sulfuric wash. Details given.

175 Schwalbe, C. *B. A.* 1904, i, 337. *Ber.* 37, 324-5. Liebermann's Thiophene Reaction. Instead of dark blue, a dirty brown test is given where thiophene is suspected of being present.

176 Schweinitz, E. A. v. *B. A.* 1886, 535. *Ber.* 19, 644-9. Octyl-derivatives of Thiophene. Prepared from octyl bromide and iodothiophene. Prepared brom, iodo, aceto, diaceto, dicarboxylic, and methyl derivatives.

177 Speilmann, P. E., and Schotz, S. P. *C. A.* 1919, 3114. *J. Soc. Chem. Ind.* 38, 188-90T. The Estimation of Thiophene. Several methods are cited for the estimation of thiophene in C_6H_6 .

178 Stadler, O. *B. A.* 1885, 764. *Ber.* 18, 530-6. Nitrothiophenes. Continuation of work with V. Meyer (*B. A.* 1885, 141 and 250). Studied dinitrothiophenes. One gives a red coloration with potash that is very delicate. Prepared mononitrothiophenesulfonic acid and the chloride and amide from it.

179 Stadler, O. *B. A.* 1885, 972. *Ber.* 18, 1490-2. Reduction of Nitrothiophene to Amidothiophene. Readily reduced by tin and saturated alcoholic hydrochloric acid. The stannochloride salt separates. Free base is bright yellow oil which soon becomes resinated.

180 Stadinkov, G., and Rakovski, V. *C. A.* 1928, 1774. *Ber.* 61B, 268-9. Acylation of Thiophene in the Presence of Tin Tetrachloride. Reaction takes place almost instantaneously in presence of $SnCl_4$.

181 Stadinkov, G., and Goldfarb, I. *C. A.* 1929, 1408. *Ber.* 61B, 2341-2. Alkylation and Acylation of Thiophene in the Presence of Tin Tetrachloride. The yield of ketones depends somewhat on the solvent. Using benzene (b. p. 120°-140°) as solvent yields of 50% to 58% obtained for acetothiophene. Other ketones given.

182 Steinkopf, W. *C. A.* 1912, 3180. *Chem. Ztg.* 35, 1098. Simple Method for the Preparation of Thiophene. By passing acetylene over pyrites heated to about 300°, a liquid is obtained containing 40% thiophene together with other sulfur compounds.

183 Steinkopf, W., and Kirchhoff, G. *C. A.* 1914, 1416. *Ann.* 403, 1-11. Preparation of Thiophene from Acetylene. C_2H_2 passed over pyrites heated to 280°-310° at rate of 150 l. per hour gave a dark condensate equal to 0.33% of the C_2H_2 . Upon fractionation the liquid gave a yield of 40% thiophene.

184 Steinkopf, W. *C. A.* 1914, 1416. *Ann.* 403, 11-16. The Change of Homologous Butadienes into Homologous Thiophenes. 152 g. isoprene passed over pyrites heated to redness gave 52 g. distillate from which 3.3 g. of 3-thiotolene was isolated. Identified as $HgCl$ compound, 240 g. $(H_2C:CH_2)_2$ gave 6.4 g. 3, 4-thioxene. Attempts to prepare ethylthiophene by passing a mixture of C_4H_8S and Et_2O vapors over the dust at 300°-320° was not successful.

185 Steinkopf, W. *C. A.* 1914, 1417. *Ann.* 403, 17-44. 2-Thiophenine. Prepared by treating C_6H_6S with fuming HNO_3 and Ac_2O . Nitro compound reduced with Sn and HCl to give 2-thiophenine, b. p. 77°-79°. Various derivatives given.

186 Steinkopf, W., and Lutzkendorf, G. C.A. 1914, 1417. *Ann.* 403, 45-9. Pyridino 2, 3-thiophene.
Prepared by heating 30 g. glycerol and 40 g. conc. sulfuric acid to 150° and gradually adding 28 g. $(C_6H_5SNH_2 \cdot HCl)_2 \cdot SnCl_4$. Yellow liquid with odor of quinoline. Forms additional compounds with $CoCl_2$, picric acid, chromates and CH_3I .

187 Steinkopf, W., and Bauermeister, M. C.A. 1914, 1418. *Ann.* 403, 50-72. Mercuric Chloride Thiophenes.
Volhard showed that thiophenes with 2 free α -positions gave a mono- and di- $HgCl_2$ compound, while if 1 position was occupied only a mono-compound was formed. Further experiments show that this is not a general rule. See abstract.

188 Steinkopf, W., and Butkiewicz, W. C.A. 1915, 459. *Ann.* 407, 94-108. Thiophene Series. VI, Condensation of Thiophene with Phthalic Anhydride.
18 g. $C_6H_4(CO)_2O$ in 200 cc. CS_2 , 10 g. C_6H_5S , and 27 g. $AlCl_3$ heated 2½ hours. CS_2 decanted, dark mass was treated with ice water and HCl . Gave 5.7 g. 0, 2-themoylbenzoic acid. M. p. 145°. Various derivatives given.

189 Steinkopf, W. C.A. 1917, 2326. *Ann.* 413, 310-33. Thiophene Series. VII, Thiophene Compounds Containing Mercury or Arsenic.*

190 Steinkopf, W., and Jaffe, D. C.A. 1917, 2327. *Ann.* 413, 333-42. VIII, Some Derivatives of 2-Acetothienone.*

191 Steinkopf, W. C.A. 1917, 2327. *Ann.* 413, 343-9. IX, New Method of Preparing Thienyl Ketones.*

192 Steinkopf, W., and Schubart, I. C.A. 1921, 2871. *Ann.* 424, 1-23. Thiophene Series. X, Preparation and Reduction of Thienyl Ketones.
2-Propiethienone, 2-butyrothienone, 2-isovalerothienone, and various other ketones and their derivatives given.

193 Steinkopf, W. C.A. 1921, 2872. *Ann.* 424, 23-61. XI, Thiophene Mercury Compounds.*

194 Steinkopf, W., and Otto, A. C.A. 1921, 2873. *Ann.* 424, 61-71. XII, Chlorination and Bromination of Thiophene with Acetochloro- or Bromo-amide.
Method of halogenation described.

195 Steinkopf, W., and Augestad-Jensen, H. C.A. 1922, 3653. *Ann.* 428, 154-63. Thiophene Studies. XIV, Condensation of Diazoacetic Ester with Thiophene.
Above products when heated in sealed tube at 126°-128° for 16 hours gave ethylbicyclo- Δ^3 -a-penthiophene-5-carboxylate.

196 Steinkopf, W., Bielenberg, W., and Augestad-Jensen, H. C.A. 1923, 560. *Ann.* 430, 41-78. Thiophene Series. XV, Ring Compounds Containing Mercury and Experiments on the Preparation of Mixed Thiophene-mercury Compounds.
Various Ilg derivatives of thiophene given.

197 Steinkopf, W., Augestad-Jensen, H., and Donat, H. C.A. 1923, 560. *Ann.* 430, 78-112. Constitution of Thiophene.
Article devoted to a study of $BrCN$ as a brominating agent.

198 Steinkopf, W., and Ohse, W. C.A. 1924, 2158. *Ann.* 437, 14-22. Thiophene Series. XVII, Preparation of the Thiophene Isolog of Cocaine.
Local anesthetic with properties similar to cocaine though less poisonous to white mice and frogs.

199 Steinkopf, W., and Wolfram, A. C.A. 1924, 2158. *Ann.* 437, 22-36. Thiophene Series. XVIII, Synthesis of the Thiophene Isolog of Atropine.
Sufficient quantity was not obtained to test its pharmacological properties.

200 Steinkopf, W., and Ohse, W. C.A. 1926, 2854. *Ann.* 448, 205-10. Thiophene Series. XIX, Thiophene-eucaine-A and Several Other Thiophene Derivatives.
In general these derivatives are less toxic than the corresponding C_6H_5 derivatives.

201 Steinkopf, W., and Muller, P. J. C.A. 1926, 2854. *Ann.* 448, 210-22. Thiophene Series. XIX, The Diazotizability of Aminothiophene.*

**202 Storch, L. B.A. 1904, i, 610. *Ber.* 37, 1961. The Indophenine Reaction.
Warm mixture gently. Solution of $FeCl_3$ or potassium dichromate simply develops heat necessary. Water produces same effect.**

**203 Thiele, A. B.A. 1892, 442. *Ann.* 267, 133-8. β -Isopropylthiophene.
Prepared from isopropylsuccinate by Volhard and Erdmann's method. Reacts with acetyl chloride or propionyl chloride and aluminum chloride.**

204 Thomas, V. C.A. 1908, 1715. *Compt. rend.* 146, 642-5. Some Derivatives of Thiophene.
Iodothiophene reacts normally with Mg to form the Grignard reagent. The latter reacts normally with aliphatic and aromatic ketones giving tertiary alcohols.

205 Thomas, V. C.A. 1910, 191. *Bull. soc. chim.* [4] 5, 730-6. Some Derivatives of Thiophene.
Aliphatic ketones react with C_6H_5S and Mg in Et_2O forming tertiary alcohols. Dimethylthiophenyl carbinol, methylethylthiophenyl carbinol, dipropylthiophenyl carbinol, methylphenylthiophenyl carbinol and diphenylthiophenyl carbinol were prepared. Distillation under reduced pressure has tendency to form unsaturated hydrocarbons.

206 Thomas, V. C.A. 1910, 301. *Bull. soc. chim.* [4] 5, 736. Reduction of the Thiophene Nucleus: A Correction.
Thiophene nucleus cannot be reduced by method of Sabatier and Senderens.

207 Thomas, V., and Couderc, V. C.A. 1919, 713. *Bull. soc. chim.* **23, 288-91.** Synthesis of Ketones in the Thiophene Series. Ethylthienyl ketone, phenylthienyl ketone, α - and β -naphthylthienyl ketone, and dithienyl ketone were prepared.

208 Thomas, V., and Couderc, V. C.A. 1919, 961. *Bull. soc. chim.* **23, 326-8.** Synthesis of Alcohols in the Thiophene Series. $\text{C}_6\text{H}_5\text{SMgI}$ reacts with ketones such as Ph_2CO to give carbinols. Several are given.

209 Thomsen, J. B.A. 1885, 1126. *Ber.* **18, 1832-3.** Constitution of Thiophene. Author is led to consider from his researches on the heat of formation of thiophene that the 4 carbon atoms are united by 5 single bands, and that it is probable that like benzene it will yield 3 bisubstitution compounds.

210 Tohl, A., and Eberhard, O. B.A. 1894, i, 117. *Ber.* **26, 2947-9.** Action of Sulfuric Acid on Chlorothiophene. Gives preparation of α -chlorothiophene. When treated with sulfuric acid it is converted into chlorothiophenesulfonic acid and chlorodithienyl (not quite pure). Derivatives given.

211 Tohl, A. B.A. 1894, i, 276. *Ber.* **27, 665-7.** Sulfonation of Thiophene and its Oxidation by Sulfuric Acid to a New Dithienyl. Thiophene (5 g.) and 50 g. faintly fuming sulfuric acid well cooled, then steam distilled to get dithienyl. Remainder of thiophene is recovered as Ba or Pb sulfonate. Dithienyl melts 33°, b.p. 260° without decomposition. Gives test with isatin. Perbromodithienyl (CsBr_2S_2) obtained by warming dithienyl in acetic acid with excess bromine. Needles, m.p. 257°. Bromothiophene is partially converted into bromodithienyl by action of conc. H_2SO_4 . Other products also formed.

212 Tohl, A., and Schultz, K. B.A. 1895, i, 86. *Ber.* **1894, 27, 2834-9.** Action of Sulfuric Acid on Bromothiophene. See (B.A. 1894, i, 117 and 276). Slightly fuming H_2SO_4 converts bromothiophene into tetrabromothiophene, the sulfonic acids of dibromo- and tribromothiophene being formed in small quantities. If fuming acid is employed perbromodithienyl and tetrabromothiophene are formed.

213 Vlastelitz, A. C.A. 1915, 1750. *J. Russ. Phys. Chem. Soc.* **46, 790-800.** α -Thiotolene, α, α' -Iodothiotolene and α, α' -Thiotolene Aldehyde. Preparation and properties of the above substances given.

214 Voerman, G. L. C.A. 1907, 2892. *Rec. trav. chim.* **26, 293-310.** On the Monocarboxylic Acids of Thiophene. A physico-chemical study of α - and β -thiophene carboxylic acid was made.

215 Volhard, J., and Erdmann, H. B.A. 1885, 763. *Ber.* **18, 454-5.** Synthesis of Thiophene. Gives methods of preparation. Best yield from sodium succinate and phosphorus trisulfide. See abstract.

216 Weisse, K. B.A. 1895, i, 543. *Ber.* **128, 1537-8.** Triphenylthienylmethane. Prepared by heating triphenylcarbinol and thiophene with phosphoric anhydride. M.p. 239°, b.p. 433°-438°, with some decomposition. Yield quantitative.

217 Weitz, L. B.A. 1884, 1130. *Ber.* **17, 792-801.** The Thiophene Group. Prepared chlor derivatives. Also sulfonic and sulfenic acids. Have the strongest resemblance to benzene derivatives, but are distinguished by the indophenine reaction.

218 Willgerodt, C. B.A. 1886, 339. *J. prakt. Chem.* [2] **33, 150-1.** Tetrachloride. C_4SCl_8 is prepared when chlorine is passed into monoiodothiophene in chloroform. Has a sharp penetrating odor.

219 Willgerodt, C. B.A. 1886, 692. *J. prakt. Chem.* [2] **33, 479-83.** Benzene Containing Thiophene. Gives lecture demonstration of removal of thiophene. Purify by use of chlorine and then distill off from the chlorine.

220 Willgerodt, C., and Schlotz, T. C.A. 1910, 2283. *J. prakt. Chem.* **81, 382-402.** Preparation of Hydrocarbons, Acids, Amides, and Thiophenes by Action of Ammonium Sulfide on Aliphatic Aromatic Ketones. A Cu autoclave lined with Pb is used. Ketones are heated with colorless solid $(\text{NH}_4)_2\text{S}$ at about 115°. Thiophene derivatives obtained only in the cases of phenylmethylketone and p-tolylmethylketone. Presence of complex aliphatic or aromatic radicals in ketone hinders formation of thiophenes.

221 Zelinsky, N. B.A. 1887, 921. *Ber.* **20, 2017-25.** Thiophene Group. Prepared 2,4-methathioxene from α -methyllevulinic acid by heating with phosphorus trisulfide. Yield 20%. Prepared acetyl, oxidized one methyl to carboxyl and then both methyls to carboxyl.

222 Zelinsky, N. B.A. 1888, 939. *Ber.* **21, 1835-9.** 3:4 Thioxene and Tetramethylthiophene. Preparations given.

CROSS REFERENCES

Group 1—34, 101, 116; **Group 2**—4, 11, 12, 13, 17, 27, 32, 39, 40, 41, 43, 44, 46, 70, 77, 88, 89, 90, 91, 92, 102, 110, 112, 116; **Group 3**—9, 42, 90, 92; **Group 5**—3, 15, 21, 59, 85, 95, 107; **Group 8**—9, 13, 17, 32; **Group 10**—42, 46, 80, 81, 110, 118, 253, 262, 398, 460; **Group 12**—37, 63, 93; **Group 13**—5; **Group 14**—41, 146, 147; **Group 15**—10; **Group 17**—29.

GROUP 19

RINGS CONTAINING MORE THAN ONE SULFUR, AS THIANTHRENE

1 Bailey, J. R., and Randolph, C. P. *C. A.* 1908, 3079. *Ber.* 41, 2494-505. Desulfurization of Thiohydantoins. Accomplished by bromine water. Thiohydantoic acids desulfurized by HgO .

2 Bezdek, A., Friedlander, P., and Koeniger, P. *C. A.* 1908, 1438. *Ber.* 41, 227-42. Derivatives of Thionaphthene. Many derivatives of the compound are described.

3 Boes, J. *B. A.* 1903, i, 50. *Chem. Zentr.* 1902, ii, 804. *Apoth. Ztg.* 17, 565. Thionaphthene Contained in Brown-coal Tar. Isolated from fraction boiling at 215°-225° by precipitation as the picric acid compound. Readily forms bromo derivatives. Peat tar and American crude petroleum do not contain thionaphthene.

4 Decker, H. *B. A.* 1906, i, 687. *Ann.* 348, 210-50. Coeroxene, its Derivatives and Isologs. See abstract for those containing sulfur.

5 Deuss, J. J. B. *C. A.* 1908, 2935. *Ber.* 41, 2329-31. Constitution of Thianthrene. When heated at 240°-250° during 4 to 5 hours with PCl_5 (7-8 mol.) is converted into benzene o-disulfonic chloride and o-dichlorobenzene.

6 Friedlander, P. *B. A.* 1907, i, 334. *Ann.* 351, 390-420. Derivatives of Thionaphthene and Thioindigotin. Prepared hydroxyl and other derivatives of thionaphthene. See abstract.

7 Fries, K., and Hemmecke, E. *C. A.* 1929, 3468. *Ann.* 470, 1-19. Thionaphthene. Nitration and subsequent reduction studies were made. Various derivatives given.

8 Fromm, E., and Soffner, M. *C. A.* 1923, 1983. *Ber.* 57B, 371-3. Isomerism of the Thioaldehydes.*

9 Fromm, E., and Schultis, C. *C. A.* 1923, 3014. *Ber.* 56B, 937-47. Isomerism of the Thioaldehydes.*

10 Gattermann, L., and Lockhart, A. E. *B. A.* 1894, i, 92. *Ber.* 26, 2808-9. Thionaphthenes. Give preparation. M. p. 30°-31°. Red coloration with concentrated sulfuric acid.

11 Genvresse, P. *B. A.* 1897, i, 514. *Bull. soc. chim.* [3] 15, 1038-48. Trihydroxyphenylenic Disulfide. Probably some new thianthrenes.

12 Giron, J. *C. A.* 1924, 1272. *Bull. sci. pharmacol.* 31, 25-7. Action of Chlorine on the Trisulfide of Trimethylene. SCl_2 and a substance very probably $CHCl_2 \cdot S \cdot CH_2Cl$ were formed.

13 Kalle and Co. *B. A.* 1907, i, 953. *D. R. P.* 184, 469. Preparation of Thionaphthene Derivatives. See abstract for method of preparation.

14 Kraft, F., and Kaschau, A. *B. A.* 1896, i, 297. *Ber.* 29, 443-5. Thianthrene and Selenthrene. Primarily concerning selenium compound corresponding to thianthrene.

15 Lebedev, S. V., and Platonov, M. *C. A.* 1926, 2657. *Ber.* 59B, 762-7. Monothio- and Dithio-triacetaldehydes.*

16 Mann, F. G., and Pope, W. J. *C. A.* 1923, 2558. *J. Chem. Soc.* 123, 1178-81. Isomeric Trithioacetaldehydes. γ -Trithioacetaldehyde, m. p. 81°, sublimes at 100°, was prepared by action of Ag_2S , H_2S , Ag_2O or $NaOH$ upon $(MeCHCl)_2S$. A solution in MeI gradually deposits the β -form, m. p. 126°.

17 Mannessier, A. *C. A.* 1916, 2892. *Gazz. chim. ital.* 46, i, 231-40. 2,3-Dithiosulfindene.*

18 Marcusson, J. *C. A.* 1912, 927. *Chimiste* 2, 359-61. The Chemical Constitution of Mineral Oils of High Boiling Points. III, Paraffins, Naphthenes and Polynaphthenes.*

19 Ray, J. N. *C. A.* 1922, 920. *J. Chem. Soc.* 119, 1959-67. Synthesis in the Thianthrene Series. Certain derivatives of thianthrene given such as dichloro-, dichlorodimethyl-.

20 Schonberg, A. *C. A.* 1929, 2708. *Ber.* 62B, 195-9. Organic Sulfur Compounds. XI, Comparison of the Dissociation Tendency of Polymeric Thio-ketones with the Dissociation Tendency of Corresponding Compounds of the Ethane Series.*

21 Smiles, S., and Ghosh, B. *C. A.* 1915, 3232. *J. Chem. Soc.* 107, 1377-81. Synthesis of Derivatives of 3-Oxy(1)thionaphthene. Methyl(1)thionaphthocoumarin, 2,2-di-benzoyl 3-oxy(1)thionaphthene and 2-benzoyl 3-oxy(1)thionaphthene are given.

22 Vanino, L. *C. A.* 1908, 2225. *J. prakt. Chem.* 77, 367-8. The Formation of Thioaldehyde. When equal quantities of fused $Na_2S_2O_3$, concentrated H_2CO solution, and 38% HCl were brought together, trithioformaldehyde was formed, M. p. 218°. In same manner paraldehyde gave trithioacetaldehyde.

23 Walther, R., and Greifenhagen. *C. A.* 1907, 1990. *J. prakt. Chem.* 75, 201-11. The Action of Bromacetophenone on Mustard Oils and Thiourethanes. Thiourethanes and complex thioethers are formed as intermediate products and finally oxythioazolines are formed.

24 Weissgerber, R., and Kruber, O. *C. A.* 1921, 88. *Ber.* 53B, 1551-65. Thionaphthene in Coal Tar. Authors found thionaphthene present in all naphthalenes obtained from coal tar, and have worked out methods for isolating it from crude and com. $C_{10}H_8$.

25 Wirth, R. *B. A.* 1906, i, 528. *Chem. Zentr.* 1906, i, 1353. Thioindigo-red.*

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Group 2—26, 38, 39, 40, 41, 42, 48; **Group 3**—5, 43; **Group 5**—59, 104; **Group 7**—2; **Group 8**—15, 27; **Group 10**—19, 20, 21, 42, 101, 139, 140, 141, 147, 148, 149, 181, 182, 205, 208, 229, 230, 253, 265; **Group 12**—41, 42, 45, 51, 62, 83; **Group 13**—6; **Group 14**—13, 50, 51, 87, 88, 179, 186; **Group 16**—4, 9; **Group 17**—10, 15; **Group 18**—21, 121.

GROUP 20

SULFONIUM COMPOUNDS

1 Berthsen, A., and Klinger, H. *B. A.* 1878, 569. *Ber.* 11, 492-5. Sulfine Compounds of Thiocarbamide. Methyl iodide adds to thiocarbamide forming methiodidethiocarbamide. This is very different from methylthiocarbamide instability, etc.

2 Cahours, A. *B. A.* 1876, i, 696. *Compt. rend.* 131, 1163-7. Researches on the Sulfines. Studied reaction of acetyl bromide and cyanogen bromide on methyl sulfide and methyl iodide on methyl sulfonyanate, to form trimethylsulfonium halide.

3 Carrara, G. *B. A.* 1894, ii, 310. *Gazz. chim. ital.* 24, i, 180-9. Effect of Neutral Solvents on the Velocity of Formation of Triethylsulfine Iodide. Velocity changes as solvent is changed. Alcohol increases velocity, acetone decreases, and action does not proceed in benzene or ether. Cause probably in solvents themselves and not a physical one.

4 Claesson, P. *B. A.* 1878, 37. *Ber.* 10, 1346-54. Action of Potassium Thiocyanate on Compounds of Monochloroacetic Acid. Prepared thiocyanacetic acid from sodium salt of chloroacetic acid and potassium thiocyanate. With hydrochloric acid forms carbaminothioglycolic acid. This heated to 110° with methyl alcohol and methyl iodide forms trimethylsulfine iodide.

5 Crum-Brown, A., and Blaikie, J. A. *B. A.* 1882, 593. *J. prakt. Chem.* [2] 23, 395-401. Trimethylsulfone Salts. Prepared trimethylsulfine thiosulfate, sulfite, oxalate, dithionate.

6 Delisle, A. *B. A.* 1892, 1433. *Ber.* 25, 2450-3. Thietincarboxylic Acids. Preparations and some reactions given.

7 Dobbin, L., and Masson, O. *J. Chem. Soc. Trans.* 1885, 56-68. Action of the Halogens on the Salts of Trimethylsulfine. Formed and studied salts such as dibromide, etc.

8 Garrara, G. *B. A.* 1894, ii, 309. *Gazz. chim. ital.* 24, i, 170-9. Velocity of Reaction Between Ethylic Iodide and Sulfide. Is second order reaction.

9 Kehrmann, F., and Duttenhofer, A. *B. A.* 1906, i, 83. *Ber.* 38, 4197-9. Aromatic Sulfine Bases. Diphenylmethyl di- α -naphthylmethyl- and di- β -naphthylmethyl-sulfine chloride and derivatives prepared.

10 Klason, P. *B. A.* 1904, i, 522. *Ber.* 37, 1349-60. Constitution of Platinum Bases. Sulfine derivatives prepared as $NH_3 \cdot Pt(NH_3Cl) \cdot SEt_2Cl$.

11 Klinger, H. *B. A.* 1878, 132. *Ber.* 10, 1877-80. Thioaldehydes. Converting the α -benzothioaldehyde to β -modification with iodine in benzene and then heating with metallic copper gives 60% yield of stilbene from β -thiobenzaldehyde used. Methyl iodide on thioacetaldehyde obtained trimethylsulfide. α -Thiobenzaldehyde is changed to β -modification in ethyl iodide.

12 Klinger, H., and Maassen, A. *B. A.* 1889, 1135. *Ann.* 252, 241-66. Sulfines and the Valency of Sulfur, II. See *B. A.* 1888, 357. Triethylsulfine iodide is changed into trimethylsulfine iodide by the action of MeOH at 130°. Not a simple reaction.

13 Michaelis, A., and Godechaux, E. *B. A.* 1891, 714. *Ber.* 24, 757-64. Aromatic Sulfines. Hexamethyltriamidotriphenylsulfine chloride and hydroxide prepared.

14 Nasini, R., and Scala, A. *B. A.* 1890, 1234. *Gazz. chim. ital.* 19, 526-8. The Sulfines and the Different Valencies of Sulfur. Polemical in nature.

15 Nasini, T., and Costa, T. *B. A.* 1891, 1305. *Gazz. chim. ital.* 21, 217-28. Molecular Refractive Energy of Some Triethylsulfine Derivatives.*

16 Nasini, R., and Costa, T. *B. A.* 1892, 34. *Gazz. chim. ital.* 21, 554-65. Sulfinic Derivatives and Their Analogies to Compounds of Organic Amines. Molecular refractive energy of sulfur compounds as triethylsulfine bromide is high.

17 Patein, G. *B. A.* 1888, 664. *Compt. rend.* 106, 861-3. Cyanogen Compounds of Sulfines. Prepared sulfine iodide and then treated it with silver cyanide. The resulting Et_3SCy and AgCy were studied.

18 Patein, G. *B. A.* 1890, 880. *Bull. soc. chim.* [3] 3, 164-71. Sulfines. Prepared double salts of trialkylsulfine cyanide and silver cyanide. Compare *B. A.* 1889, 234.

19 Pope, W. J., and Peachey, S. J. *Proc. Chem. Soc.* 1900, 12. The Space Configuration of Quadrivalent Sulfur Derivatives. Methylethylthetinedextrocampahorsulfonate and Dextro α -bromocampahorsulfonate. See journal.

20 Pope, W. J., and Peachey, S. J. *J. Chem. Soc. Trans.* 1900, 1072-75. Asymmetric Optically Active Sulfur Compounds, d-Methylethylthetineplatinochloride. See paper.

21 Reychler, A. *B. A.* 1906, i, 5. *Bull. soc. chim.* [3] 33, 1226-32. Trithioformaldehyde and a New Method of Preparing Trimethylsulfonium Iodide. Trithioformaldehyde may be purified by recrystallization from hot aniline and subsequently washing with HCl and alcohol. It reacts with CH_3I when heated in sealed tube at 80° - 100° forming trimethylsulfonium iodide. Methyl alcohol added gives better yield. Reaction much more complex if ethyl alcohol or ethyl iodide is used.

22 Smiles, S. *J. Chem. Soc. Trans.* 1900, 1174-9. A Contribution to the Stereochemistry of Sulfur. An Optically Active Sulfine Base. Prepared methyl, ethyl, and organic acid sulfonium bases.

23 Smiles, S. *Proc. Chem. Soc.* 1905, 92. An Asymmetric Synthesis of Quadrivalent Sulfur. Prepared 1-methyl ester of methylethylthetine bromide and derivatives.

24 Smiles, S. *J. Chem. Soc. Trans.* 1905, 450-61. An Asymmetric Synthesis of Quadrivalent Sulfur. Sulfonium compounds studied—thetine esters.

25 Smiles, S., and Le Rossignol, R. *Proc. Chem. Soc.* 1906, 24 and 158. Triarylsulfonium Bases. Can be prepared: 1. by the action of thionyl chloride on a phenol or phenolic ether in presence of AlCl_3 ; 2. by the action of a sulfinic acid on a phenolic ether in presence of concentrated sulfuric acid; 3. by the condensation of an aromatic sulfoxide with phenols or their ethers.

26 Smiles, S., and Le Rossignol, R. *J. Chem. Soc. Trans.* 1906, 696-708. Aromatic Sulfonium Bases. Gives preparation of a large number.

27 Smiles, S., and Hilditch, T. P. *C. A.* 1907, 1412. *Proc. Chem. Soc.* 23, 35-6. Camphor β -Sulfinic Acid and Camphorylsulfonium bases. Formed by reduction of camphor sulfonic acid chloride with Zn dust. Converted into sulfonic acid by oxidation.

28 Stromholm, D. *B. A.* 1900, i, 325. *Ber.* 33, 823-41. Sulfine and Thetine Derivatives. Prepared many sulfine double salts as platinum and picrates.

CROSS REFERENCES

Group 2—24, 41, 64, 96; **Group 8**—6; **Group 10**—15, 55, 140, 212, 259, 307, 327, 335, 343, 375, 409, 415, 428, 437, 438, 440, 441; **Group 11**—17, 40; **Group 12**—26, 29, 43, 47, 48, 50, 87; **Group 13**—13; **Group 14**—2, 3, 14, 21, 23, 29, 32, 36, 37, 39, 40, 52, 53, 62, 66, 70, 72, 73, 108, 112, 120, 141, 156, 163, 166, 185, 191, 198, 204, 205; **Group 15**—1, 3, 4, 5, 6, 7, 8, 13; **Group 17**—10, 36.

GROUP 21

THIOALDEHYDES AND POLYMERS

1 Baumann, E. *B. A.* 1890, 477. *Ber.* 23, 60-9. Thioaldehydes. A résumé of the preparation of thioaldehydes in solution. See abstract.

2 Baumann, E., and Camps, R. *B. A.* 1890, 478. *Ber.* 23, 69-73. Thioaldehydes. Oxidation of α - and β -trithioaldehydes to trisulfone by KMnO_4 .

3 Baumann, E., and Fromm, E. *B. A.* 1891, 1008-11. *Ber.* 24, 1419-30, 1457-69. Isomerism of Thioaldehydes (1st

paper) Trithio-derivatives of Acetaldehyde and Polymeric Thioformaldehyde.*

4 Baumann, E., and Fromm, E. *B. A.* 1891, 1050. *Ber.* 24, 1431-40. Thio-derivatives of Benzaldehyde. See *B. A.* 1891, 1050; *Ber.* 24, 1441-56.

5 Baumann, E., and Fromm, E. *B. A.* 1892, 301. *Ber.* 24, 3591-9. Thio-derivatives of Furfuraldehyde. From furfuraldehyde in alcoholic hydrochloric acid solution with H_2S .

6 **Berthsen, A. B.A. 1877, ii, 887.** *Ber.* 10, 36-8. Action of Nascent Hydrogen in Thiobenzamide.
Thiobenzamide with sodium amalgam gives thiobenzaldehyde, while with zinc and hydrochloric acid gives primary amine.

7 **Bottinger, C. B.A. 1879, 791.** *Ber.* 12, 1053-7. Benzal Sulfide and Thiobenzaldehyde.
Benzal sulfide in alcohol undergoes no change on boiling with concentrated HCl or HCN. Gently heated in a silver dish with concentrated solution of potash yields benzyl mercaptan, benzyl disulfide and small amount of benzoic acid. Benzal sulfide is insoluble in a solution of sodium hydrogen sulfite. Thiobenzaldehyde is separated from benzaldehyde with sodium acid sulfate.

8 **Bottinger, C. B.A. 1894, i, 402.** *Arch. Pharm.* 232, 1-3. Detection of Glyoxylic Acid.
Dichloracetic acid with ammonium hydrosulfide formed compound which gave lead salt $(CH_3COO)_2Pb$. On decomposition of salt with H_2S gave acid, extremely volatile and unstable. Forms colorless compound with phenylhydrazine.

9 **Brunel, H. B.A. 1897, i, 14.** *Bull. soc. chim.* [3] 15, 134. Thioglyoxylic (Ethanethiolic) Acid.
By the action of sodium sulfide on dichloracetic acid. Decomposes on distilling in vacuum. Forms unstable lead and silver salts. By boiling aqueous solution of the acid with HgO , glyoxylic acid is produced.

10 **Drugman, J., and Stockings, W. E.** *Proc. Chem. Soc.* 1904, 115-7. Note on the Action of Hydrogen Sulfide on Formaldehyde and Acetaldehyde Solutions.
See for literature references and experimental work. In neutral solution H_2S can be used to detect formaldehyde in presence of higher aliphatic aldehydes.

11 **Fromm, E. B.A. 1900, i, 14.** *Ber.* 32, 2650-3. History of Thioacetaldehydes.
Polemical as to ring structure.

12 **Guareschi, G. J. B.A. 1879, 710-2.** *Gazz. chim. ital.* 9, 75-89. Ethylidene-disulfuric Acid.
Prepared by the action of potassium permanganate on thioaldehyde. Forms K, Ba, Na, Ca, Mg, Cd, and Cu salts. Both sulfonic groups attached to the same carbon. Theoretical discussion. See abstract.

13 **Klinger, H. B.A. 1877, ii, 305.** *Ber.* 9, 1893-6. On Thioaldehydes.
Treat aldehydes with dry hydrogen sulfide to obtain thioaldehyde. This polymerizes with acid. See abstract.

14 **Klinger, H. B.A. 1878, 720-21.** *Ber.* 11, 1023-7. Thioaldehydes.
 α - and β -modifications differ in solubility. Gives preparation of α -thioacetaldehyde. α -Thioacetaldehyde forms 2 compounds with silver nitrate which do not deposit silver sulfide on boiling with alcohol. Crystalline compounds with mercuric chloride, platinum chloride, and silver nitrate easily distinguishes α - from β .

15 **Klinger, H. B.A. 1899, i, 859.** *Ber.* 32, 2194-5. Thioacetaldehydes.
Polemical.

16 **Kopp, K. B.A. 1894, i, 128.** *Ann.* 277, 339-61. See. *B.A.* 1892, 718. Thioaldehydes and Their Conversion into Derivatives of Stilbene.
Dissolve aldehyde in well-cooled alcoholic solution of HCl, treating with H_2S for 2 to 2½ hours at $-10^\circ C$. and allow to stand for 2 days. Avoid excess HCl. Separates with 3 mol. EtOH. Warming with alcoholic KOH forms stilbene derivatives. Same with large excess iron powder. See abstract or paper.

17 **Marckwald, W. B.A. 1886, 864.** *Ber.* 19, 1826-32. Decomposition Products of Thioaldehyde Thiocyanate.
Studied thioacetaldehyde.

18 **Marckwald, W. B.A. 1886, 1005.** *Ber.* 19, 2378-82. Methylthioaldehydes.
Thioaldehyde reacts with methylamine as well as ammonia. On boiling methylthioaldehyde in aqueous solution, γ -trithioaldehyde, and dithioaldehyde isothiocyanate are formed.

19 **Marckwald, W. B.A. 1888, 127.** *Ber.* 20, 2817-8. Trithioacetaldehydes.
 γ -Modification mixed with 4 times its weight of ethyl iodide goes to β -modification. Cause is not iodine for similar experiment with iodine did not give β -modification.

20 **Morana, C. B.A. 1906, i, 23.** *D.R.P.* 162059. Thio-compounds Prepared from Ketones and Aldehydes.
Condensation of aldehydes and ketones in a solution of alkali sulfides or polysulfides.

21 **Peters, W. B.A. 1905, i, 625.** *Ber.* 38, 2565-7. Trimethylenetrisulfone and Disulfone Sulfide.
Prepared brom derivatives on both sulfur and carbon. Properties of derivatives studied.

22 **Pfeiffer, A. B.A. 1872, 1001.** *Ber.* 5, 699. Remarks on Isobutyl Aldehyde.
 H_2S with isobutyl aldehyde gave an oil which could not be converted to crystalline body. Abominable alliaceous odor. Can distill with H_2O ; with NH_3 , gave a solid.

23 **Pratesi, L. B.A. 1885, 240.** *Gazz. chim. ital.* 14, 139-41. Trioxymethylene.
Compares $(CH_2O)_3$ with $(CH_2S)_3$. Discusses principally the polymers of formaldehyde.

24 **Pulvermacher, G. B.A. 1892, 579.** *Ber.* 25, 304-11. Some Reactions of Trithioformaldehyde and Formaldehyde.
Formation of nitrogen derivatives by removal of the sulfur.

25 **Schroeder, A. B.A. 1871, 559.** *Ber.* 4, 400. Researches on Valeraldehyde.
 $Dry H_2S$ does not react with valeraldehyde while moist does. Showed by analysis and density that $C_6H_{10}S$ is formed (sulfovaleraldehyde). Insoluble in alcohol and ether. Smell most offensive and

persistent. M.p. 69°. Heated strongly decomposes and gives off white fumes having an indescribable smell. May be sublimed without decomposition in vacuum.

26 Schroeder, A. B.A. 1871, 706. *Ber.* 4, 468. Researches on Valeraldehyde. Studied reaction of thiovaleraldehyde and ammonia forming valeralidine. Also studied reaction with aqueous ammonia, CS_2 , and valeraldehyde.

27 Suwyer, J. F. B.A. 1905, i, 741. *Rec. trav. chim.* 24, 377-403. Transformations of the Isomeric Trithioaldehydes. Studied transformations from α - to β -forms and their properties.

28 Vanino, L. B.A. 1902, i, 744. *Ber.* 35, 3251-2. A New Method of Preparing Trithioformaldehyde. Add acid to a solution of sodium thiosulfate with formaldehyde, no precipitation of sulfur takes place in the cold. On warming the mixture some sulfur is separated and ultimately trithioformaldehyde is precipitated.

29 Wohl, A. B.A. 1887, 27. *Ber.* 19, 2344-7. Derivatives of Thioformaldehyde. Thiometaldehyde is obtained when an aqueous or alcoholic solution of hexamethyleneamine is saturated with H_2S . Methythioformaldine and derivatives prepared.

30 Worner, E. B.A. 1896, i, 225. *Ber.* 29, 139-60. Isomerism of Trithioaldehydes. Author summarizes his results. See abstract.

CROSS REFERENCES

Group 2—6, 7, 8, 9, 11, 46, 58, 102; **Group 3**—1, 7, 21, 68; **Group 5**—110; **Group 10**—128, 151, 277, 387, 395, 406; **Group 12**—57; **Group 13**—6, 10; **Group 14**—91; **Group 17**—7, 11, 12, 41; **Group 18**—8, 77; **Group 19**—8, 9, 12, 15, 16, 22; **Group 20**—11, 21.

GROUP 22

THIOKETONES AND POLYMERS

1 Aldringen, F. B.A. 1890, 624. *Chem. Zentr.* 1890, i, 119-20. Thiocoumarins and Their Behavior Towards Hydroxylamine and Phenylhydrazine.*

2 Aldringen, F. B.A. 1892, 329. *Ber.* 24, 3459-66. Thiocoumarin and its Analogs. With hydroxylamine splits out H_2S . Other reactions studied.

3 Behr, A. B.A. 1873, 276. *Ber.* 5, 970-2. On Sulfobenzophenone and a Product of the Distillation of Barium Benzoate. $(\text{C}_6\text{H}_5)_2\text{C}:\text{S}$ is formed by action of alcoholic K_2S and chloride of benzophenone. Cryst. from CS_2 in large prisms, m.p. 152°-153°. Ox. agents convert it to benzophenone. On distillation decomposes forming tetraphenylethylene, badly smelling oil, and carbon.

4 Clayton, A. C.A. 1908, 1440. *Proc. Chem. Soc.* 24, 26; *J. Chem. Soc.* 93-4, 524-31. The Residual Affinity of the Coumarins and Thiocoumarins as Shown by Their Additive Compounds. Form additional compounds with HgCl_2 . Thiocoumarins formed by action of P_2S_5 on corresponding coumarins. Unlike coumarins they yield oximes and phenylhydrazones.

5 Clayton, A. C.A. 1908, 1966. *J. Chem. Soc.* 93-4, 524-31. The Residual Affinity of the Coumarins and Thiocoumarins as Shown by Their Additive Compounds. Certain cobaltic cyanides, oximes, and hydrazones are prepared. See preceding reference.

6 Fromm, E., and Ziersch, P. B.A. 1906, i, 930. *Ber.* 39, 3599-3609. Thioderivatives of Ketones. 1,3-diketones react with H_2S in presence of HCl, forming thioderivatives of the bisdiketones. These were studied.

7 Gattermann, L., and Schulze, H. B.A. 1897, i, 192. *Ber.* 29, 2944-5. Thiobenzophenone. Not possible to obtain pure thiobenzophenone from benzophenone and phosphorus pentasulfide. Better obtained if benzophenone chloride is treated with alcoholic potassium sulfide. Thiobenzophenone is converted into benzophenone with alcoholic potash, with hydroxylamine gives benzophenoneoxime, and on heating with CuO yields tetraphenylethylene.

8 Graebe, C., and Roder, P. B.A. 1899, i, 705. *Ber.* 32, 1688-90. Oxime and Phenylhydrazone of Xanthone. Boils xanthone in alcoholic solution of H_2S to form xanthione.

9 Gutbier, A. B.A. 1901, i, 96. *Ber.* 33, 3358-9. Thio 1-methylpyridone and Thio 1-methylquinoline. Prepared by heating 1-methylpyridone with P_2S_5 for 4 to 5 hours at 130°. Feebly basic, dissolving in concentrated H_2SO_4 or HCl. Quinoline derivative obtained similarly.

10 Guthzeit, M., and Epstein, W. B.A. 1887, 920. *Ber.* 20, 2111-3. Action of Phosphoric Sulfide on Ethyldimethylpyronedicarboxalate. Prepared ethylthiodimethylpyronedicarboxylate.

11 Leteur, F. B.A. 1903, i, 605. *Compt. rend.* 136, 1459-60. Action of Hydrogen Sulfide on Methylethylketone.

Saturate methylethylketone with HCl at -28° to -30° and treat with dry hydrogen sulfide, forms polymer of butanethione. Does not liquify at -25° , boils at 238° at 175 mm.

12 **Muller, H. B. A.** 1890, 43. *Ber.* **22**, 2401-12. Substituted Amidoximes. Prepared thiobenzoparatomluide from benzoparatomluide and phosphorus pentasulfide.

13 **Schonberg, S.**, (with Rosenbach, A., Krull, H., and Ostwald, U.). *C. A.* 1926, 364. *Ber.* **58B**, 1793-801. Organic Sulfur Compounds. III, Thioketones. An investigation of the chemistry of thioketones as compared with that of the ordinary ketones.

14 **Schonberg, A., Schutz, O.**, and Nickel, S. *C. A.* 1928, 4510. *Ber.* **61B**, 1375-85. Organic Sulfur Compounds. IX, Preparation of Aromatic Thioketones by the Action of Thioacetic Acid on Ketone Chlorides. Action of Copper-bronze on Thiobenzophenone and its Derivatives.*

15 **Spring, W. B. A.** 1881, 711. *Ber.* **14**, 758-60. Formation of Acetone and Thioacetone. Propidenedichloride, CCl_2Me_2 , is decomposed by sodium thioacetate yielding sodium chloride and thioacetic ether. Latter yields thioacetone when heated.

16 **Stieglitz, J. B. A.** 1890, 254. *Ber.* **22**, 3148-60. Behavior of Amidoximes Towards Diazobenzene Derivatives. Thiobenzorthotoluide is formed by fusing benzorthotoluide with phosphoric pentasulfide.

17 **Tiemann, F. B. A.** 1886, 880. *Ber.* **19**, 1661-7. Thiocoumarin and its Derivatives. Prepared from coumarin and phosphorus pentasulfide. Reacts with hydroxylamine and phenylhydrazine.

18 **Willgerodt, C. B. A.** 1887, 1045. *Ber.* **20**, 2467-70. Action of Yellow Ammonium Sulfide on Ketones and Quinones. The reaction of yellow ammonium sulfide on ketones and quinones is very variable, depending on the constitution of the compound, the proportion of sulfur in the ammonium sulfide, and the temperature at which the reaction is effected. See abstract.

CROSS REFERENCES

Group 2—13, 60; Group 3—8, 41, 55, 61, 86; Group 5—107; Group 8—25; Group 9—2, 3, 7, 9; Group 10—256, 381, 401, 426; Group 12—64, 65; Group 13—7; Group 14—5, 8, 18, 154, 187, 188; Group 17—18; Group 21—20.

GROUP 23

THIOACIDS

1 **Alvarez, N. C. A.** 1920, 1090. *Bol. minero soc. nac. mineria. (Chile)* **31**, 181-91. Thioacetic Acid as a Reagent. Acid prepared by treating glacial CH_3COOH with P_2S_5 . When heated acid liberates H_2S and is used to precipitate sulfide.

2 **Auger, V., and Billy, M. B. A.** 1903, i, 310. *Compt. rend.* **136**, 555-7. Thioacids, $\text{R}\cdot\text{CO}\cdot\text{SH}$. Studied the action of NaSH on many of the derivatives of the acids. See abstract.

3 **Auger, V. B. A.** 1905, i, 14. *Compt. rend.* **139**, 798-800. Thioformic Acid. Prepared by distilling in vacuum formic acid and sodium metathiophosphate. Phenyl formate reacts readily with sodium hydrosulfide in absolute alcoholic solution.

4 **Baker, R. B., and Reid, E. E. C. A.** 1929, 2939. *J. Am. Chem. Soc.* **51**, 1567-70. Claisen Ester Condensation with Ethyl Thiolacetate. AcSEt condenses with Na to give 15% of Et acetothiolacetate. This shows the ketone and acid hydrolysis as does $\text{AcCH}_2\text{CO}_2\text{Et}$.

5 **Berthsen, A. B. A.** 1878, 70. *Ber.* **10**, 1238-42. Thioamides of Monobasic Organic Acids.

Amidines treated with hydrogen sulfide yield thioamides.

6 **Berthsen, A. B. A.** 1878, 585. *Ber.* **11**, 503. Action of Phosphorus Pentasulfide on Acid Amides. Gently warm a mixture of phosphorus pentasulfide and twice its weight of benzoanilide. The syrupy mass is extracted with alcohol, caustic soda is added and the solution is poured into water. On addition of hydrochloric acid the benzothioanilide is precipitated.

7 **Berthsen, A. B. A.** 1882, 381. *Ann.* **211**, 85-99. Suggestions Respecting the Nomenclature of Carbonic Acid Derivatives. Due to the confusing names, recommends a systematic nomenclature. Discusses the cases where nitrogen and sulfur are also involved.

8 **Blank, P. B. A.** 1893, i, 8. *Ber.* **25**, 3040-7. Derivatives of Trimethylenechlorobromide. γ -Thiodibutyramide is prepared from γ -thiodithiobutyronitrile (Gabriel, *B. A.* 1890, 1221) by dropping into conc. H_2SO_4 , cooled by ice; m. p. 152° . Hydrolysis gives γ -thiodibutyric acid, which on oxidation gives the sulfone. Prepared γ -phenoxybutyrothioamide from γ -phenoxybutyronitrile in 5% alc. ammonia saturated with H_2S .

9 **Bruni, G., and Levi, T. G. C. A. 1924, 2693.** *Atti. accad. Lincei* **32**, i, 5-8. A Method for the Preparation of Organic Dithio Acids.
Prepared by action of $(\text{NH}_4)_2\text{S}_x$ on aldehydes with or without presence of EtOH which acts as a solvent.

10 **Clarke, H. T., and Hartman, W. W. C. A. 1924, 2497.** *J. Am. Chem. Soc.* **46**, 1731-3. Preparation of Thioacetic Acid.
Prepared by passing H_2S into Ac_2O containing about 20% AcCl .

11 **Delapine, M. C. A. 1908, 2375.** *Compt. rend.* **146**, 981-5. Properties of the Metallic Salts of Dithiocarbamic Acid.
The Ni , Na , Ba , Cu , Zn , Co , Ag , Ph , and Fe salts are given.

12 **Delmont, L. B. A. 1892, 421.** *J. pharm. chim.* [5] **24**, 425-9. Action of Potassium and Sodium Sulfides on Chloroform.
Formation of thioformic acid..

13 **Dupre, A. B. A. 1878, 568.** *Compt. rend.* **86**, 665-8. Substitution of Oxygen for Sulfur in the Fatty Acids.
Discusses the thio-acids. Prepares and studies thiosulfopropionic acid.

14 **Emmerling, O. B. A. 1896, i, 127.** *Ber.* **28**, 2882-8. Thiorufic and Thiocarbacetoacetic Acid.*

15 **Fleischer, A. B. A. 1876, ii, 73.** *Ber.* **9**, 436-40. On Cyanic Acid Compounds.
Discusses formula of ammonium oxysulfocarbamate.

16 **Formanek, J. B. A. 1890, 29.** *Ber.* **22**, 2655-6. Dithioxamide (Cyanogen Disulfhydrate).
Gives preparation of $\text{NH}_2 \cdot \text{CS} \cdot \text{CS} \cdot \text{NH}_2$.

17 **Franchimont, A. B. A. 1873, 390.** *Ber.* **5**, 1048-50. Dibenzylidicarbonic Acid.
Formed cryst. sulfuretted compound which decomposed by water forming phenylbromacetic acid.

18 **Graebe, C., and Zschokke, B. B. A. 1884, 1925.** *Ber.* **17**, 1175-7. Thio-phthalic Anhydride.
Add slowly phthalic chloride to a cold concentrated solution of sodium hydrogen sulfide. Acidify and thiophthalic anhydride precipitates. Prepared thiofluorescein. Has a different absorption spectrum from fluorescein.

19 **Hantzsch, A., and Bucerius, W. C. A. 1926, 2661.** *Ber.* **59B**, 793-814. Constitution of the Dithiocarboxylic Acids and Their Salts.*

20 **Hofmann, A. W. B. A. 1878, 396.** *Ber.* **11**, 338-40. Preparation of Thio-amides.
Use phosphorus sulfide on corresponding oxygen compounds.

21 **Hofmann, K. A., and Hochlein, F. B. A. 1903, ii, 428.** *Ber.* **36**, 1146-9. Thiocarbonates of Heavy Metals.
See abstract for salts prepared.

22 **Hohn, F., and Bugge, G. C. A. 1911, 1265.** *J. prakt. Chem.* **82**, 473-85. Hydrogen Persulfide. V, Aldehydes and Hydrogen Persulfide.
 H_2S_2 converts aldehydes into carbithionic acids. Phenyl-, α -hydroxyphenyl, and p -methoxyphenyl-carbithionic acids were prepared. Gentle oxidation gives the thiacyldisulfides.

23 **Holmberg, B. B. A. 1905, i, 323.** *J. prakt. Chem.* [2] **71**, 264-95. Ester-acids of Sulfur Substituted Carbamic Acids with Aliphatic Hydroxy-acids.
Many thiocarbo acids as well as xanthates prepared.

24 **Holmberg, B. B. A. 1906, i, 330.** *J. prakt. Chem.* [2] **73**, 239-48. Thiocarbonates.*

25 **Houben, J. B. A. 1906, i, 847.** *Ber.* **39**, 3219-33. Carbithionic Acids. I, Arylcarbithionic Acids.
See abstracts for various acids and salts prepared.

26 **Houben, J., and Schultz, K. M. L. C. A. 1910, 3232.** *Ber.* **43**, 2481-5. Carbithionic Acids. IV, Esters of Perthioacetic, Perthiopropionic and Perthiophenyl Acetic Acid.
The methyl esters of the above acids are given.

27 **Jones, H. O., and Tasker, H. S. C. A. 4, 746.** *Proc. Chem. Soc.* **95**, 159. Thio-oxalates.
Esters of dithio-oxalic acid prepared by action of alkyl hydrosulfides on oxalyl chloride. Diethyl, dimethyl and diphenyl esters given.

28 **Levi, T. G. C. A. 1929, 3438.** *Atti. accad. Lincei* [6] **9**, 170-5. Dithioformic Acid.
 K salt was prepared as follows: $\text{CHCl}_3 + 2\text{K}_2\text{S} = \text{HCS}_2\text{K} + 3\text{KCl}$. Various derivatives given.

29 **Lipmann, E. B. A. 1890, 163.** *Monatsh.* **10**, 617-23. Carbothionyllic Acids of Resorcinol and Pyrogallol.
Prepared the phenol by heating with potassium xanthate, yield 60%.

30 **Losner, L. B. A. 1875, 640-2.** *J. prakt. Chem.* [2] **10**, 235-61. Action of Benzoyl Chloride on Potassium Sulfocyanate in Alcoholic Solution.
Action of potassium thiocyanate on benzoyl chloride in alc. solution forms benzoyl ethylsulfocarbonic acid. See paper or abstract for details.

31 **Mermet, A. B. A. 1876, i, 744.** *Bull. soc. chim.* [2] **24**, 433-4. On a Delicate Test for Sulfocarbonates of the Monosulfides ($\text{MS} \cdot \text{CS}_2$) in Solution.
One drop of decinormal solution of pure Ni salt in excess of NH_3 until it is decolorized gives light green tint with monosulfides, yellow with polysulfides, brown or black with alkaline monosulfides, and yellow with sulfcarbonates of disulfides. Sensitive to 1 part in 60,000.

32 Meyer, P. J. *B. A.* 1881, 890. *Ber.* 14, 1507-9. Ethyl mono- and di-Chlorothiocacetates.
Ethylmonochlorothioacetate obtained by action of phosphorus pentasulfide on ethyl monochloroacetate at 120°-140°. Ethyl dichlorothioacetate formed in same way.

33 Michler, W. *B. A.* 1875, 258. *Ber.* 7, 1312-3. Thio-ethers.
Prepared from thiophenol and acetyl chloride. Several acid chlorides were treated with mercaptans to form thio esters.

34 Moro, N. V. *B. A.* 1897, ii, 16. *Gazz. chim. ital.* 26, i, 494-501. Velocity of Formation of Alkali Xanthogenates. (Alkali Ethylic α , β -Dithiocarbonates.)
Third order reaction between CS_2 , KOH and EtOH. No satisfactory solvent.

35 Nencki, M. *B. A.* 1878, 663. *J. prakt. Chem.* [2] 17, 69-70. Note on Carbamine Sulfatic Acid (Carbaminesulfoglycollic Acid).
See Claesson (*B. A.* 1878, i, 37).

36 Nicol, W. W. J. *B. A.* 1882, 589. *Proc. Roy. Soc. Edinburgh* 10, 425. Action of Potassium Sulfide on Chloroform.
Produces potassium sulfhydrate and potassium thioformate which is converted into formate by mercuric oxide. Free acid cannot be prepared. See Pfannkuck (*B. A.* 1873, 363).

37 O'Donoghue, I. G., and Kohan, Z. K. *C. A.* 1907, 717. *J. Chem. Soc.* 89, 1812. Thiocarbonic Acid and Some of its Salts.
 H_2CS_3 prepared by action of concentrated HCl on $CaCS_3$. Soluble in most organic solvents, decomposed by water, stable towards strong acids, volatile, dissolves flowers of sulfur. Salts are unstable.

38 Pribram, R., and Glucksmann, C. *B. A.* 1893, i, 75. *Monatsh.* 13, 623-34. Behavior of Thiocarbonates Towards Phenols.
Resorcinol carbothionylic acid is obtained by heating together at 100° resorcinol and potassium thiocarbonate. M. p. 150°-155°.
Heated with excess alkali hydroxide yields metadihydroxybenzoic acid.

39 Rayman, B. *B. A.* 1887, 950. *Bull. soc. chim.* 47, 896-8. Action of Arsenious Sulfide on the Acid Chlorides.
Prepared benzoylthioarsenite and mercury α -thiobenzoate from benzoyl chloride. From phthalyl chloride prepared thiophthalic anhydride.

40 Rehlander, P. *B. A.* 1894, i, 619. *Ber.* 27, 2154-61. Oxazolines and Thiazolines of the Anisic Acid Series.
Thioanisamide was prepared by distilling anisic acid with lead thiocyanate and treating the anisonitrile thus obtained with alcoholic ammonium sulfide at 100°. Reaction with ethylene bromide and trimethylene bromide given.

41 Rivier, M. H. *C. A.* 1907, 170. *Bull. soc. chim.* [3] 35, 837-43. On Phenylchlorothiocarbonates.

Prepared by action of thiophosgene in $CHCl_3$ solution on phenol in NaOH solution. Certain carbamates are given.

42 Sakurada, Y. *C. A.* 1927, 2458. *Mem. Coll. Sci. Kyoto*, 9, 237-41. Carbolthionic Acids and Esters.
Several thionic esters were obtained by treating the imino ether with H_2S . Acids obtained from esters by action of alc. KOH.

43 Sakurada, Y. *C. A.* 1927, 3609. *Mem. Coll. Sci. Kyoto* 10, 79-83. Carbolthionic Acids and Esters. III, Carbithionic Acids and Esters.
Various carbithionic esters were prepared by passing H_2S into ethereal solutions of the corresponding thioimino esters. Acids obtained by hydrolysis of these esters with alc. KOH.

44 Sakurada, Y. *C. A.* 1928, 764. *Bull. Chem. Soc. Japan* 2, 307-10. Carbolthionic Acids and Their Esters. IV, New Method for the Formation of Thioamides and Thiohydrazides.*

45 Salomon, F. *B. A.* 1873, 617-20. *J. prakt. chim.* [2] 6, 433-53. On Sulfocarbonic Ethers.
Prepared ethyl monosulfocarbonate. Odor of rotten fruit. With KOH forms K_2CO_3 and mercaptan and alcohol. Discusses thiocarbonates. See abstract or original.

46 Salomon, F. *B. A.* 1873, 1222. *J. prakt. Chem.* [2] 7, 252-8. Sulfuretted Chlorocarbonic Ethers.
Studied different thiocarbonic esters.

47 Salomon, F. *B. A.* 1876, i, 559. *Ber.* 8, 1506-9. On the Intermediate Formation of Anhydrides in Chemical Reactions.
Studied thio-acids. See abstract.

48 Scala, A. *B. A.* 1887, 800. *Gazz. chim. ital.* 17, 78-82. Propylxanthic Acid.
Prepared potassium propyl xanthate, the copper, silver, lead, and mercury salts as well as the propyl, methyl, and ethyl salts. The free acid rapidly decomposes into its constituents.

49 Schall, C. *B. A.* 1897, i, 191. *J. prakt. Chem.* [2] 54, 415-21. Elimination of Sulfur from Resorcinodithiocarboxylic Acid.
Treat with alcoholic potash and excess methyl iodide. Naphthol heated with potassium sulfide and CS_2 for 12 hours on a water bath forms di α -hydroxynaphthyl thione disulfide.

50 Schall, C., and Kraszler, S. *B. A.* 1899, i, 414. *Z. Elektrochem.* 5, 225-6. Electrolytic Preparation of Dithion-disulfides.
Electrolysis of aqueous solutions of potassium methyl, isobutyl, and isoamyl xanthates yields corresponding disulfides at the anode. See abstract.

51 Schiff, R., and Tarugi, N. P. *B. A.* 1895, ii, 84. *Ber.* 27, 3437-9. Thioacetic Acid as a Substitute for Hydrogen Sulfide in Qualitative Analysis.

Using thioacetic acid in place of H_2S in qualitative analysis in laboratories of the University of Pisa.

52 Schiff, R. B.A. 1895, ii, 370. Ber. 28, 1204-6. Preparation of Thioacetic Acid, and its Application in Chemico-Legal Investigation.
Prepared by acting on glacial acetic acid with phosphorus pentasulfide. Thioacetic acid is free from arsenic so it can be used to generate hydrogen sulfide to determine arsenic.

53 Schreder, J. B.A. 1874, 990. Ber. 7, 704-8. On the Three Isomeric Thiophthalic Acids.
Recommends decomposition of phenyl ethers with KSH for preparation. Prepared potassium thiophthalate and thiophthalic anhydride. Prepared thiophthalic acid.

54 Spilker, A. B.A. 1890, 141. Ber. 22, 2767-90. Nitrogen Derivatives of Salicylic Acid.
Salicylothioamide is prepared from amide and phosphorus pentasulfide.

55 Staudinger, H., and Siegwart, J. C.A. 1921, 516. Helvetica Chim. Acta 3, 824-33. Thiobenzoyl Chloride. Prepared by action of Cl_2 and $SOCl_2$ on $PhCS_2H$ in 50 cc. Et_2O . Has properties of $RCOCl$, but less stable.

56 Tarugi, N. B.A. 1896, i, 125. Gazz. chim. ital. 25, i, 341-52. Behavior of Thioacetic Acid with Salt Solutions. Formation of salts. See abstract.

57 Tarugi, N. B.A. 1897, i, 553. Gazz. chim. ital. 27, i, 316-28. Behavior of Thioacetic Acid Towards Salt Solutions.
Bismuth salts tend to decompose yielding H_2S .

58 Tarugi, N. B.A. 1898, i, 123. Gazz. chim. ital. 27, ii, 153-66. Thio-organic Compounds of Arsenic.
At low temperature and with sufficient sodium carbonate to neutralize the HCl produced, thioacetic acid forms $(MeCOS)_2AsCl$. Thioacetic acid also studied with AsI_3 and arsenites. See abstracts.

59 Tchugaeff, L. B.A. 1898, ii, 495. Ber. 31, 1775-82. Optical Activity.
Measured amyl sulfite and amyl $S \cdot CS \cdot OEt$ and amyl $EtS \cdot CSO$.

60 Thenard, P. B.A. 1875, 143. Compt. rend. 79, 673-6. Barium Sulfocarbonate.
Recommends $BaCS_3$ as an insecticide in wine districts.

61 Troeger, J., and Ewers, E. B.A. 1900, i, 210. J. prakt. Chem. [2] 60, 520-3. α -Dichlorothiopropionamide. Prepared by passing H_2S into nitrile.

62 Weddige, A. J. Chem. Soc. 1871, 900. J. prakt. Chem. [2] 4, 59. Action of Potassium Sulphydrate on Benzoyl Chloride.
Alcoholic solution of KSH produces on benzoyl chloride a crystalline body and not thiobenzoic acid. It may be benzoyl sulfide.

63 Welde, H. B.A. 1876, ii, 624. Ber. 9, 1044-8. Sulfodicarbonic Acids.
Equivalent quantities of ethylchlorocarbonate and potassium xanthate react to form ethylsulfodicarbothionate. Reactions studied.

64 Welde, H. B.A. 1877, ii, 314-8. J. prakt. Chem. [2] 15, 43-62. The Sulfo-dicarbonic Acids.
Discusses products formed as sulfur replaces oxygen in the dicarbonic acids. See abstracts or original.

65 Wheeler, A. S., and Thomas, C. L. C.A. 1929, 115. J. Am. Chem. Soc. 50, 3106-9. p -Cymene Studies. XI, p -Cymyl 2-carbithioic Acid.
The preparation, properties, and derivatives of the acid are given.

66 Wheeler, H. L. B.A. 1901, i, 636. J. Am. Chem. Soc. 23, 443-9. Additive Reactions of Thiol Acids.
Thiobenzoic acid reacts with methyl alcohol forming methyl benzoate. Forms salt with diisobutylamine. Reacts with phenylthiocarbimide.

67 Wuyts, H. C.A. 1929, 4939. Bull. soc. chim. Belg. 38, 195-204. The Action of Phenylhydrazine on the Aromatic Dithio-acids.*

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Group 2—13, 37, 46, 60, 104; **Group 3**—29, 64, 70; **Group 4**—6, 15, 24; **Group 5**—11, 32, 33, 43, 55, 56, 61, 62, 66, 82, 83, 86, 97, 103, 108; **Group 9**—2, 3, 5, 6; **Group 10**—11, 16, 26, 53, 55, 93, 94, 95, 109, 110, 117, 137, 138, 152, 156, 176, 185, 210, 213, 249, 262, 266, 269, 282, 301, 322, 350, 365, 367, 373, 382, 383, 388, 393, 429; **Group 11**—35, 39, 46; **Group 12**—5, 18, 36, 38, 46, 53, 54, 56, 57, 60; **Group 13**—3, 4; **Group 14**—155, 196; **Group 21**—6; **Group 22**—14, 15.

GROUP 24

ALIPHATIC ACIDS WHERE THERE IS SUBSTITUTION IN THE CARBON CHAIN OF SULFUR (MOSTLY OF BIOLOGICAL VALUE)

1 **Andreasch, R. B.A. 1886, 786.** *Mosnath.* 7, 158-75. Sulfochloracetic Acid. Prepared by action of chlorosulfonic acid on monochloracetic acid.

2 **Bottinger, C. B.A. 1879, 45.** *Ber.* 11, 1561. Monosulfolactic Acid. Explanation of different samples.

3 **Bottinger, C. B.A. 1894, i, 491.** *Arch. Pharm.* 232, 244-8. Action of Ammonium Hydrosulfide on Dichloracetic Acid. Gives preparation of thioglycolic acid. See same author (B.A. 1894, i, 466).

4 **Buchka, K., and Sprague, C. B.A. 1890, 28.** *Ber.* 22, 2541-56. Ethylthioacetacetate. See Buchka (B.A. 1885, 1200); Delisle (B.A. 1887, 915). Treated with phenylhydrazines.

5 **Buchka, K., and Sprague, C. B.A. 1890, 796.** *Ber.* 23, 847-55. Action of Phenylhydrazine on Ethylthioacetacetate. Formation of pyrazolone.

6 **Chanlaroff, M. B.A. 1883, 39.** *Ber.* 15, 1987-9. Action of Thioacetic Acid on Ethylthiocyanate. Forms acetylthiocarbamate.

7 **Claesson, P. B.A. 1877, ii, 595.** *Liebig's Ann. Chem.* 187, 113-26. Thioglycolic Acid. Prepared from chloracetic acid and potassium sulfhydrate. Prepared salts.

8 **Fischer, E., and Gerngross, O. C.A. 1909, 2154.** *Ber.* 42, 1485-95. Derivatives of L-Cystine. Various acyl derivatives of L-cystine given.

9 **Franchimont. B.A. 1881, 716.** *Compt. rend.* 92, 1054-6. Action of Sulfuric Acid on Acetic Anhydride. Forms sulfacetac acid.

10 **Franchimont, A. P. N. B.A. 1888, 1175.** *Rec. trav. chem.* 7, 25-33. Sulfacetac Acid and its Derivatives. Higher homologs prepared.

11 **Frerichs, G., and Beckurts, H. B.A. 1900, i, 478.** *Arch. Pharm.* 238, 9-15. The Thiocyanoacetic Acids.*

12 **Frerichs, G., and Wildt, E. C.A. 1908, 2075.** *Ann.* 360, 105-27. On the Action of Sodium Hydroxide on Compounds of Dithio- and Diselenoglycolic Acids. Alcoholic alkalies with dithioglycolic acid yield thioglycolic and thio-oxalic acid derivatives. Other derivatives also given.

13 **Freytag, B. B.A. 1880, 312.** *J. prakt. Chem.* [2] 20, 380-2. Some Derivatives of Propionic Acid.

14 **Holmberg, B. C.A. 1908, 1691.** *Z. anorg. Chem.* 56, 385. Antimony and Stannic Thioglycollic Acids. When the sulfo salts of Sb, As, or Sn react with the Na salt of chloracetic acid, no formation of a mercaptide acid takes place. Cleavage products of the latter are formed. Na metasulfantimonate and the latter give the Na salt of dithioglycollic acid.

15 **Loven, J. M. B.A. 1895, i, 82.** *Ber.* 1894, 27; 3059-60. Preparation of Thiodiglycollic Acid. Method outlined giving yield of 84%.

16 **Loven, J. M. B.A. 1897, i, 15.** *Z. physik. Chem.* 21, 134-6. Trithiodilactic Acid. By the interaction of H_2S and pyruvic acid, a sulfur compound was obtained considered to be trithiodilactic acid. Conductivity measured, and e.m.f. of silver salt of acid.

17 **Mauzelius, R. B.A. 1883, 821.** *Ber.* 21, 1550-2. Alkyl Salts of Sulfoacetic Acid and Ethylenedisulfonic Acid. Prepared $CHMe(SO_3Et)_2$, $CMeEt(SO_3H)_2$, and $SO_3Et \cdot CH_2COOEt$.

18 **Messel, R. B.A. 1871, 131.** *Ann. Chem. Pharm.* 158, 15. On Sulfomaleic Acid. Potassium sulfite and fumaric or maleic acid give a sulfomaleic acid, $COOH-CH_2CHSO_3OH-COOH$. Properties given.

19 **Neuberg, C., and Asher, E. C.A. 1908, 72.** *Biochem. Z.* 5, 451-5. Aminocystine and Aminoethanedisulfide. Cystine may be converted into α -hydroxy β -thiopropionic acid by action of dil. H_2SO_4 . Ba salt of the disulfide of the acid reacts with $HgCl_2$, $PbAc_2$, $CuAc_2$, and $AgNO_3$. When cystine is dry distilled aminoethanedisulfide is formed.

20 **Porcher, C. B.A. 1902, i, 527.** *Bull. soc. chim.* [3] 27, 438-41. Attempt to Resolve Monochlorosulfoacetic Acid into Optical Isomerides. Use of the cinchonine salt. Results unsuccessful.

21 **Rosenthal, T. B.A. 1886, 866.** *Ann.* 233, 15-38. β -Sulfopropionic Acid. From β -iodopropionic acid and ammonium sulfite. Prepared salts.

22 **Scheibler, H., and Bube, W. C.A. 1915, 3245.** *Ber.* 48, 1445-61. Unsaturated Sulfidedicarboxylic Acids. I, β -Sulfidedicarboxylic Acids. Their preparation and properties given.

23 **Schwalbe, C. G. C.A. 1907, 1845.** *Z. angew. Chem.* 20, 656. Preparation of Thioglycolic Acid.

Credit is given to Blanksma for the preparation by reduction of dithioglycolic acid obtained by interaction of chloroacetic acid and sodium sulfide.

24 Siegfried, M. B.A. 1095, i, 59. Z. physiol. Chem. 43, 68-71. Derivatives of Amino-acids.
Amino-acids react with 4-nitrotoluene 2-sulfonic chloride to form sulfoamino acid. Forms monochlorosulfacetylechloride.

25 Siemens, R. B.A. 1873, 1022. Ber. 6, 659-62. Action of Phosphorus Pentachloride on Sulfacetic Acid.

26 Sprague, C. D. J. Chem. Soc. Trans. 1891, 329-43. Ethylthioacetacetate. Formed pyrazolone derivatives which were studied.

27 Troeger, J., and Ewers, E. B.A. 1900, i, 494. Arch. Pharm. 238, 309-20. Alkylthiosulfonated Ethylacetacetate.
Thiosulfonates do not condense easily with chlorketones but readily with α -chloracetacetate and β -naphthylthiosulfonic acid.

28 Vaillant, V. B.A. 1896, i, 591. Bull. soc. chim. [3] 13, 1094-5. Action of Carbonyl Chloride on Dithioacetylacetone.
With excess carbonyl chloride in benzene solution, a small amount of dimethyl-diacetylpyrone was formed (stood 2 months).

29 Varda, G. de. B.A. 1889, 35. Rend. Acad. dei Lincei [4] 4, 1. Chem. Zentr. 1888, 887-8. Sulfoisovaleric Acid.
Isovaleric acid and chlorsulfonic acid form sulfoisovaleric acid. Decomposes on heating on water bath.

30 Weddige, A. B.A. 1874, 566. J. prakt. Chem. [2] 9, 132-43. Some Sulfuretted Derivatives of Oxalic Acid.
Passed H_2S into ethylcyanocarbonate until saturated. Studied the ethylsulfoxamide so formed.

31 Wegscheider, R. B.A. 1902, ii, 643. Monatsh. 23, 599-668. Dissociation of Dibasic Acids.
Studied thiodiglycollic, dithiodiglycollic, thiodiacetic, α -thiodipropionic, and α -thiopropionacetic acids.

32 Wieland, T. B.A. 1871, 132. Ann. Chem. Pharm. 157, 34. On Sulfopyrotartaric Acid.
Gives preparation and properties of some of the salts of sulfopyrotartaric acid.

33 Zanetti, C. U. B.A. 1889, 960. Chem. Zentr. 1889, 668. Rend. Acad. dei Lincei [4] 5, i, 225-7. Thiosuccinic Anhydride.
Reaction with aniline and phenyhydrazine.

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GROUP 25

SULFONIC ACIDS, LARGELY ALIPHATIC AND CYCLIC, WITH SOME REFERENCES TO AROMATIC

1 Armstrong, H. E. B.A. 1874, 804. Ber. 7, 406. Action of Sodium Formate on Potassium Benzenedisulfonate.
Unsuccessful attempts to obtain isophthalic or terephthalic acids by fusion.

2 Armstrong, H. E., and Miller, A. K. J. Chem. Soc. Trans. 1884, 148-56. Studies on Sulfonic Acids, I.
On the hydrolysis of sulfonic acids and on recovery of the benzenes from their sulfonic acids.

3 Autenrieth, W., and Rudolph, P. B.A. 1902, i, 22. Ber. 34, 3467-82. Interaction of Aliphatic Disulfonic-chlorides and Aromatic Amino-compounds.
Prepared sulfonanilides of various aliphatic compounds.

4 Autenrieth, W., and Koburger, J. B.A. 1904, i, 34. Ber. 36, 3626-34. Action of Aromatic Amines on Ethylenedisulfonicchloride. Derivatives of Vinylsulfonic Acid.
See abstract for compounds prepared.

5 Bagnall, E. H. Proc. Chem. Soc. 1898, 182. Methanetrisulfonic Acid.
Preparation and salts given.

6 Bagnall, E. H. J. Chem. Soc. 1899, 278-86. Methanetrisulfonic Acid.
Preparation and salts.

7 Barbaglia, G. B.A. 1872, 490. Ber. 5, 270. On Benzylsulfonic Acid.
Benzylsulfonic acid salt distilled with KCN gave a volatile cyanide giving α -toluic acid. Discussion of configuration.

8 Bauer, R. B.A. 1885, 1139-41. *Ann. 229*, 353-71. Azobenzenethiosulfonic and Azobenzenesulfinic Acids. See abstract for salts formed, solubilities, etc.

9 Bender, C. B.A. 1871, 702. *Ber. 4*, 517. An Acetonesulfonic Acid. Acetonesulfonic acid was prepared and salts formed. $\text{CH}_3\text{CO} \cdot \text{CH}_2\text{SO}_3\text{H}$.

10 Berthelot, M. B.A. 1876, i, 872. *Compt. rend.* 132, 185-91. Calorimetric Experiments on the Action of Fuming Sulfuric Acid upon Hydrocarbons. Studies action of sulfuric acid on benzene, toluene, ethylene and amylene. See abstract.

11 Berthelot, M. P. E. B.A. 1899, i, 397. *Compt. rend.* 128, 333-9. Action of Sulfuric Acid on Acetylene. Formation of sulfonic acid. See *B.A.* 1899, i, 264.

12 Billeter, O. B.A. 1903, i, 484. *Arch. sci. phys. nat. [4] 15*, 335-6. Action of Silver Cyanate on Aryl Chlorides. Silver cyanate reacts with benzenesulfonichloride to form benzenesulfonic anhydride. Insoluble in water. Compare Abrahall (*Trans. Chem. Soc.* 26, 606).

13 Bitto, Bela von. B.A. 1897, i, 461. *Ber. 30*, 1642-8. α -Sulfocaproic Acid and its Salts. Prepared from ammonium sulfate and a bromoethylcaproate. Salts described.

14 Blackshear, C. C. B.A. 1893, i, 94. *Am. Chem. J.* 14, 455-73. Sulfonephthaleins. Separation of ortho and para sulfamine benzoic acids given.

15 Bogert, M. T. B.A. 1903, i, 404. *J. Am. Chem. Soc.* 25, 289-91. n-Heptylthiocyanate and Some New Alkyl Esters of Dithiocarbamic Acid. Prepared n-heptylthiocyanate, sulfonic acid, and dithiocarbamate.

16 Bouchardat, G., and Lafont, J. B.A. 1894, i, 612. *Compt. rend.* 119, 85-7. Action of Sulfuric Acid on Camphene. Some borneolsulfonic acid formed.

17 Carl, F. B.A. 1880, 28. *Ber. 12*, 1604-7. Changes of Ammonium Isethionate at High Temperature. On heating at 210° - 220° loses 12% of its weight to form $\text{NH}_4\text{SO}_3 \cdot (\text{CH}_2)_2 \cdot \text{O} \cdot (\text{CH}_2)_2 \text{SO}_3\text{NH}$ and another substance supposed to be $\text{NH}_4\text{SO}_3 \cdot (\text{CH}_2)_2 \cdot \text{SO}_3(\text{CH}_2)_2\text{OH}$.

18 Carl, F. B.A. 1881, 581. *Ber. 14*, 63-7. Isethionic Acid. Oxidized with chromic acid to sulfatic acid. See *B.A.* 1879, 28.

19 Charante, J. Moll. van. B.A. 1905, i, 16. *Proc. K. Akad. Wetensch. (Amsterdam)* 7, 275-7. Sulfoisobutyric Acid. Prepared by the action of sulfuric acid (1 mol.) on isobutyric anhydride (2 mol.). Derivatives prepared.

20 Clarke, G. P. B.A. 1871, 452. *Chem. News*, 23, 145. On the Reactions of Various Oils with Sulfuric Acid. One part sulfuric acid and 25 parts oil were allowed to react. See paper.

21 Claus, A., and Cratz, C. B.A. 1880, 632. *Ber. 13*, 901-2. Paracymene and Sulfuric Acid. Forms two sulfonic acids. Note: See P. Spica (*Gazz. chim. ital.* 9, 367, 10, 254-5, *B.A.* 1880, 890), where this work had been done previously. See Claus (*Ber.* 13, 2044-5, *B.A.* 1881, 174) as a reply to Spica.

22 Claus, A., and Seelmann, A. B.A. 1895, i, 684. *J. prakt. Chem.* [2] 52, 1-8. Isoquinolinesulfonic Acids. Isoquinoline heated with fuming sulfuric acid, 50% to 60% anhydride; 2 sulfonic acids formed.

23 Cojazzi, F. B.A. 1900, i, 327. *Gazz. chim. ital.* 30, i, 187-8. Energy of Some Hydroxysulfonic Acids. Measured velocity of hydrolysis of methyl acetate by means of hydroxy methane, hydroxy ethane, and hydroxy pentane-sulfonic acids. Values slightly less than for the values for the isomeric alkyl hydrogen sulfates.

24 Conrad, M., and Fischer, W. B.A. 1893, i, 221. *Ann.* 273, 102-17. α -Naphtholsulfonic Acids. Studied the sulfonation products of *α*-naphthol.

25 Dashiell, P. J. B.A. 1893, i, 343. *Am. Chem. J.* 15, 126-9. Parethoxy-orthotoluenesulfonic Acid and its Derivatives. Gives synthesis and salts.

26 Delepine, M. B.A. 1902, i, 133. *Compt. rend.* 133, 876-8. Action of Fuming Sulfuric Acid on Acetaldehyde, Propaldehyde, and Acetone. Vapor of acetaldehyde passed into fuming sulfuric acid (50% SO_3) yield acetaldehyde, β, β -disulfonic acid and methane disulfonic acid. Propaldehyde yields the β, β -disulfonic acid and acetone yields α, γ, γ -trisulfonic acid. Salts prepared.

27 Duguet, B.A. 1902, i, 428. *Rec. trav. chim.* [2] 21, 75-86. Sulfamides and Sulfanilides of the Aliphatic Series. Prepared derivatives from propyl, isobutyl, and isoamyl.

28 Ebersbach, F. P. B.A. 1893, ii, 450. *Z. physik. Chem.* 11, 608-32. Affinity Coefficients of Aromatic Amidosulfonic Acids. Determined by electrical conductivity.

29 Engelke, J. B.A. 1883, 972. *Ann. 218*, 269-83. Dialkyldisulfisethionic Acids. Formation of double salts as $\text{C}_2\text{H}_4(\text{OH})\text{SO}_3\text{Na} \cdot \text{SO}_3\text{Me}_2$.

30 Erlenmeyer, E. B.A. 1871, 553. *Ann. Chem. Pharm.* 58, 260. On the Formation of a Methylisethionic Acid. Discusses formation of a methylisethionic acid by different methods and probable formula. $\text{CH}_3, \text{CHOH} \cdot \text{CH}_2\text{SO}_3\text{H}$.

31 Fischer, O., and Riemerschmid, C. *B. A.* 1883, 923. *Ber.* 16, 1183-5. Pyridinemonosulfonic Acid. See *Ber.* 15, 62 for preparation. Sparingly soluble in alcohol or ether. Can eliminate sulfonic group easily with reducing agents or by bromine.

32 Friedel, C., and Crafts, J. M. *B. A.* 1889, 1200. *Compt. rend.* 109, 95-9. Decomposition of Sulfonic Acids in Presence of Phosphoric Acids. Shows the formation of disulfonic acids.

33 Geuther, A. *B. A.* 1883, 973. *Ann.* 218, 288-302. Constitution of the Double Compounds of the Sulfonates with Alkyl Sulfates: Constitution and Dimorphism of Sulfates. Discusses formula of the double compound of alkyl sulfate and metal isethionate. See work of Laube, Stengel, and Engelcke (*B. A.* 1883, 972).

34 Hedin, S. G. *B. A.* 1891, 202. *Ber.* 23, 3196-9. Condensation Products of Amino-acids with Benzenesulfonic-chloride. See Hinsberg (*B. A.* 1891, 49). Formed derivatives of alanine, leucine, aspartic acid, and tyrosine.

35 Heftter, A. *B. A.* 1884, 454. *Ann.* 221, 345-9. Paramidotolueneorthothiolsulfonic Acid. Prepared thiosulfonic acid and its salts. Sodium amalgam converts it into the sulfonic acid.

36 Hemilian, W. *B. A.* 1873, 1021. *Ber.* 6, 562-3. Preparation of Organic Sulfo-acids. Ammonium sulfite is better than potassium sulfite for the preparation of sulfo-acids from the halogen substituted acid.

37 Heusler, F. *B. A.* 1895, i, 258. *Ber.* 28, 498-501. Formation of Normal Alkylic Sulfates When Tar Oils Are Washed With Sulfuric Acid. A New Method of Separating Alkylic Sulfates and Sulfonates. Tar oil washed with strong sulfuric acid was found to contain dicyclic sulfate. Supposed to have a method of separating alkyl sulfate from sulfonate.

38 Hill, H. B., and Palmer, A. W. *B. A.* 1885, 1204. *Ber.* 18, 2095-7. Sulfo-pyromucic Acid. Slowly add pyromucic acid to fuming sulfuric acid and β -sulfopyromucic acid is obtained. Formed barium, lead, and silver salts.

39 Hill, H. B., and Palmer, A. W. *B. A.* 1889, 37. *Am. Chem. J.* 10, 373-91. Substituted Pyromucic Acids. Behavior of pyromucic acid is similar to that of benzoic acid.

40 Hill, H. B., and Hendrixson, W. S. *B. A.* 1893, i, 313. *Am. Chem. J.* 15, 145-8. Chlorosulfopyromucic Acids. β -Chloropyromucic acid and fuming sulfuric acid forms β -chloro δ -sulfopyromucic acid. Other sulfo acids also described. Salts and properties given.

41 Hinsberg, O. *B. A.* 1893, i, 168. *Ann.* 272, 229-33. Benzenesulfonamides. Prepared sulfonamides by treating sulfon chloride with amine.

42 Hubner, R. *B. A.* 1884, 1126. *Ann.* 223, 198-235. Derivatives of Isethionic Acid. Prepares monochlorethanesulfonic acid and salts.

43 James, J. W. *J. Chem. Soc. Trans.* 1879, 806-11. On Ethylenchlorothiocyanate and its Oxidation into Chlorethylsulfonic Acid. Treated ethylenchlorobromide with potassium thiocyanate to form chlorothiocyanate. On oxidation slowly with HNO_3 , forms chlorethylsulfonic acid. Heated with ammonia obtained taurine.

44 James, J. W. *J. Chem. Soc. Trans.* 1883, 37-44. On Ethylenchlorobromide and Some Compounds Obtained From It. Prepared chlorthiocyanate, thiocyanate sulfonic acid, and other sulfonic acids.

45 James, J. W. *J. Chem. Soc. Trans.* 1885, 365-6. Preparation of Ethylenchlorothiocyanate and β -Chlorethylsulfonic Acid. Prepared β -chlorethylthiocyanate from ethylenchlorobromide and potassium thiocyanate. Thiocyanate oxidized with nitric acid yields β -chlorethylsulfonic acid. Analyzed as lead salt.

46 James, J. W. *J. Chem. Soc. Trans.* 1885, 367-75. Action of Primary, Secondary and Tertiary Monamines on Their Respective Salts of β -Chlorethylsulfonic Acid. Heat amine salt of β -chlorethylsulfonic acid with amine in a sealed tube for 10 hours at 160°. Add excess barium hydroxide to decompose hydrochloride. Prepared several substituted taurines.

47 James, J. W. *J. Chem. Soc. Trans.* 1886, 486-92. Derivatives of Taurine, II. Prepared trimethyltaurine and studied some of its reactions.

48 Juillard, P. *B. A.* 1893, i, 348. *Bull. soc. chim.* [3] 7, 619-21. Indigotin Tri- and Tetra-sulfonic Acids. Gives preparation and purification of salts.

49 Juillard, P. *B. A.* 1893, i, 455. *Chem. Zentr.* 1893, i, 185-7, from *Bull. soc. indust. Mulhouse* 1892, 415-91. Turkey Red Oil. Discusses action of sulfuric acid on ricinoleic acid. See abstract.

50 Kammerer, H. *B. A.* 1871, 552. *Ber.* 4, 219. On Organic Derivatives of Sulfuric Acid. Organic derivatives of sulfuric acid of both aromatic and aliphatic type formed by reaction of Ag_2SO_4 and halide. No definite products given.

51 Kastle, J. H., and Murrill, P. *B. A.* 1895, i, 370. *Am. Chem. J.* 17, 290-7.

Hydrolysis of the Ethereal Salts of Sulfonic Acids by Alcohols.

Krafft and Roos (*B. A.* 1892, 1219; 1894, i, 91) have shown that ethereal salts of sulfonic acids readily undergo hydrolysis when treated with alcohol to prepare ethers. Factors controlling this reaction discussed.

52 **Kastle, J. H., Murrill, P., and Frazer, J. C.** *B. A.* 1898, i, 140. *Am. Chem. J.* 19, 894-901. Decomposition of Alkyl Sulfonates by Water, Acids and Salts. Used ethylparabromobenzenesulfonate.

53 **Kelbe, W. B. A.** 1883, 806. *Ber.* 16, 617-9. Displacement of the Sulfonic Group by Chlorine.

Chlorine is passed into aqueous solution of cymenesulfonic acid kept cool with ice until a considerable quantity of chlorine hydrate has formed. Vessel is then well closed and heated to 40° in a water bath when the chlorine hydrate disappears. Tetrachlorcymene is formed.

54 **Kelbe, W. B. A.** 1882, 618. *Ber.* 15, 39-42. Displacement of the Sulfogroup by Bromine. Discussed cymene derivative. See also *B. A.* 1882, 300.

55 **Kelbe, W. B. A.** 1886, 355. *Ber.* 19, 92-4. Hydrolysis of Aromatic Sulfonic Acids By Means of Superheated Steam.

Results better if steam is passed through red hot coil first.

56 **Kipping, F. S., and Pope W. J.** *J. Chem. Soc. Trans.* 1893, 548-604. Sulfonic Derivatives of Camphor. Studies sulfonation of camphor.

57 **Knoevenagel, E., and Mercklin, E.** *B. A.* 1904, i, 981. *Ber.* 37, 4087-94. Alkylated Aminoacetonitriles.

Diethylamine, formaldehyde, and sodium hydrogen sulfite yield sodium diethylaminomethanesulfonate.

58 **Knoevenagel, E., and Lebach, H. B. A.** 1904, i, 994. *Ber.* 37, 4094-4104. Acylaminomethanesulfonic Salts and their Behavior Towards Potassium Cyanide.*

59 **Knoevenagel, E. B. A.** 1904, i, 1024. *Ber.* 37, 4038-59. Addition of Alkali Hydrogen Sulfites and of Sulfurous Acid to Unsaturated Compounds. Forms sulfonic acids. See abstract.

60 **Knoevenagel, E., and Lange, E.** *B. A.* 1904, i, 1027. *Ber.* 37, 4059-65. Action of Potassium Cyanide on the Additive Compounds of Alkali Hydrogen Sulfites and Unsaturated Compounds.

When heated with concentrated aqueous solution of KCN the sulfonate of 1,3-dimethylcyclohexene(3)one(5)hydrosulfonate is replaced by CN.

61 **Koenigs, W., and Hoerlin, J.** *B. A.* 1893, i, 363. *Ber.* 26, 811-7. See Perkin (*B. A.* 1893, 109.) Sulfocamphylic Acid.

Sulfonic acid formed by heating camphoric acid with strong sulfuric acid on a water bath. Salts given.

62 **Koenigs, W., and Meyer, C.** *B. A.* 1895, i, 154. *Ber.* 27, 3465-70. Sulfocamphylic Acid.*

63 **Koenig, W. B. A.** 1875, 140. *Ber.* 7, 1163-4. Action of Phosphorus Pentachloride on Ethenedisulfonic Acid. Prepared ethenedisulfonic chloride. Studied decomposition.

64 **Kohler, E. P. B. A.** 1898, i, 19. *Am. Chem. J.* 20, 680-95. Aliphatic Sulfonic Acids. Continuation of former work on unsaturated sulfonic acids.

65 **Kohler, E. P. B. A.** 1898, i, 68. *Am. Chem. J.* 19, 728-52. Aliphatic Sulfonic Acids. Prepared 23 sulfonic acids and these were studied with phosphorus pentachloride. See abstract or original.

66 **Kohler, E. P. B. A.** 1899, i, 488. *Am. Chem. J.* 21, 349-70. Aliphatic Sulfonic Acids. Continuation of previous work with unsaturated aliphatic sulfonic acids and derivatives of them.

67 **Kohler, E. P. B. A.** 1904, i, 320. *Am. Chem. J.* 31, 243-56. Addition of Acid Sulfites to Cinnamylidenemalonic Acid. Sulfonic acids prepared.

68 **Krafft, F., and Wilke, W.** *B. A.* 1901, i, 74. *Ber.* 33, 3207-9. Isolation of Sulfonic Acids by Vacuum Distillation. Can distill sulfonic acids if "cathode-light" vacuum is used. Distilled benzene, p-toluene, p-xylene, p-chlorbenzene, p-bromobenzene sulfonic acids.

69 **Kurbatow, A. B. A.** 1875, 57. *Ann. Chem. Pharm.* 173, 7-8. Ethylic Ethylsulfonate. Prepared by heating ethyl iodide with silver sulfite in ether.

70 **Lachaud, M., and Lepierre, C.** *B. A.* 1893, i, 411. *Bull. soc. chim.* [3] 7, 649-51. Oxidation and Sulfonation of Organic Compounds by Ammonium Hydrogen Sulfate. Add naphthalene, pyrine, aniline, etc., to fused NH_4HSO_4 . Water soluble products are formed.

71 **Lagai, G. B. A.** 1892, 1089. *Ber.* 25, 1836-9. Ethoxyphenylsulfonic Acids. Gives preparation and some derivatives.

72 **Lang, J. B. A.** 1877, i, 481. *Bull. soc. chim.* [2] 25, 180-3. The Derivatives of Bile-acids. Studied salts of taurine.

73 **Lermantoff, J. B. A.** 1875, 144. *Ber.* 7, 1282-4. Methene Sulfocyanate. Prepared from methene iodide and potassium sulfocyanate. Very pungent, attacking mucous membranes. Oxidized by nitric acid to disulfonic acids.

74 **Leymann, H. B. A.** 1885, 786. *Ber.* 18, 869-72. Action of β -Chlorethylene-sulfonic Chloride on Aniline. Prepared anilides of substituted taurines. See abstract.

75 **Limprecht, H. B.A.** 1873, 1040. *Ber.* 6, 534. Benzylsulfonic Chloride. Prepared from potassium benzenesulfonate and phosphorus pentachloride. When strongly heated gives off sulfur dioxide and forms benzyl chloride. Ammonia converts it into amide.

76 **Limprecht, H. B.A.** 1885, 984. *Ber.* 18, 1468-75. Azobenzenethiosulfonic Acids and Azobenzenesulfinic Acids.*

77 **Limprecht, H. B.A.** 1894, i, 292. *Ann.* 278, 239-60. Thiosulfonic Acids and Sulfinic Acids. Discusses thiosulfonic and sulfinic acids, also disulfoxides. These compounds are benzene derivatives.

78 **Loew, O. B.A.** 1891, 237. *Ber.* 23, 3125-6. Catalytic Reduction of the Sulfonic Group. Sodium hydroxymethylenesulfonate is reduced but others are not.

79 **Marekwald, W., and Frahne, H. H. B.A.** 1898, i, 666. *Ber.* 31, 1854-65. Hydroxysulfonic Acids and Sulfones. Prepared γ -hydroxypropanesulfonic acid by boiling allylic alcohol with strong solution of potassium hydrogen sulfite. Aromatic hydroxysulfonic acid also prepared.

80 **Mayer, F. B.A.** 1890, 748. *Ber.* 23, 908-12. Preparation of Ethylsulfonic Acid. Prepared by heating sodium ethyl sulfate (1 part), sodium sulfate (2 parts) and water (1 part) under pressure at 110°-120° for 3 or 4 hours.

81 **McGowan, G. B.A.** 1884, 1126. *J. prakt. Chem.* [2] 29, 138-9. Trichloromethylsulfonic Chloride. Studied reaction with ammonia.

82 **McGowan, G. B.A.** 1885, 367. *J. prakt. Chem.* [2] 30, 280-304. Trichloromethylsulfonic Chloride and the Derivatives of Methylsulfonic Acid. Continuation of former work (B.A. 1884, 1126).

83 **Michaelis, A., and Wagner, G. B.A.** 1875, 139. *Ber.* 7, 1073-5. On the Constitution of Ethyl Sulfite. Compares constitution of diethyl sulfite and ethyl ester of ethylsulfonic acid.

84 **Mohr, G. B.A.** 1884, 69. *Ann.* 221, 215-29. Benzylsulfonic Acid. Studies paramidobenzylsulfonic acid. See abstract.

85 **Monari, A. B.A.** 1885, 970. *Ber.* 18, 1343-50. New Sulfonic Acids. See abstract for new di- and tri-sulfonic acids prepared from alkyl bromides and ammonium sulfites.

86 **Monte, P. B. da, and Zoso, A. B.A.** 1898, ii, 277. *Gazz. chim. ital.* 27, ii, 467-75. Energy of Some Toluenesulfonic and Xylenesulfonic Acids. Conductivity measurements made.

87 **Moore, F. J. B.A.** 1900, i, 550. *Ber.* 33, 2014-5. Removal of a Sulfo-group by Reduction.

When p-sulfocinnamic acid is reduced with sodium amalgam or amalgamated aluminum, hydrocinnamic acid is formed.

88 **Muller, M. B.A.** 1874, 45. *Ber.* 6, 1031-4. Oxymethanesulfonic Acid and Oxymethanedisulfonic Acid. Prepares isethionic acid, alcohol and sulfuric anhydride. Can prepare mono- and di-sulfonic acids from methyl alcohol also.

89 **Muthmann, W. B.A.** 1898, i, 614. *Ber.* 31, 1880-4. Formation of Methanedisulfonic Acid by the Action of Acetylene on Fuming Sulfuric Acid. Gives off CO_2 and SO_2 during reaction.

90 **Nishack, B.A.** 1883, 972. *Ann.* 218, 283-8. Methylsulfonic Acid. Prepared metal salts.

91 **Noelting, E. B.A.** 1883, 38. *Bull. soc. chim.* [2] 37, 392-4. Dissociation of Trichloromethylsulfochloride. $\text{CCl}_3\text{SO}_2\text{Cl}$ in sealed tubes at 200° decomposes into CCl_4 , SO_2 , COCl_2 and SOCl_2 .

92 **Obermiller, J. C.A.** 1908, 1557. *Ber.* 41, 696-702. Conditions of the Formation of Phenolsulfonic Acids. A low temperature and dilute sulfuric acid favor formation of o-acid. Transformation of the o- into p-acid takes place at 60°-70° but proceeds more rapidly at 100°. Change is, however, incomplete.

93 **Ostwald, W. B.A.** 1884, 812. *J. prakt. Chem.* [2] 29, 49-57. Determination of Chemical Affinities. VI, Solubility of Hydrogen Potassium Tartrate in Dilute Acids. Studied methyl, ethyl, and propyl sulfuric acids, ethyl sulfonic acid, isethionic acid, and benzenesulfonic acid.

94 **Otto, R., and Rossing, A. B.A.** 1886, 710. *Ber.* 19, 1224-7. Oxidation of Aromatic Sulfonic Ethers to Sulfonates. Mode of formation of alkyl sulfonates makes it probable that they are derivatives of acids of the formula RSO_2OH rather than RSO_2H . Gives oxidation of ethylbenzenesulfonate to sulfonic acid.

95 **Otto, R., and Milch, A. B.A.** 1888, 281. *Ber.* 20, 3337-8. Synthesis of Anhydrides of Aromatic Sulfinic Acids. Sodium benzenesulfinate and phosgene gas yield benzene sulfinic anhydride $(\text{PhSO})_2\text{O}$. This compound is insoluble in ether, but is decomposed by water or alcohol forming the acid or the ethyl salt respectively.

96 **Otto, R., and Troger, J. B.A.** 1891, 719. *Ber.* 24, 488-91. Action of Zinc Ethyl on Aromatic Sulfonic Iodides. Obtained ethyl iodide zinc salt of the sulfinic acid.

97 **Otto, R., and Troger, J. B.A.** 1891, 924-6. *Ber.* 24, 1125-45. Thioanhydrides of Aromatic Thiosulfonic Acids and Polythiosulfonic Acids.*

98 **Otto, R., and Rossing, A. B.A.** 1891, 926-7. *Ber.* 24, 1147-56. Aromatic and Aliphatic Thiosulfonic Acids.*

99 **Otto, R., and Rossing, A. B.A. 1892, 478.** *Ber.* **24**, 3874-83. Aromatic Thiosulfonic Acids. Studied the replacement of the OH group in sulfonic acids by SH. Derivatives prepared.

100 **Otto, R., and Troger, J. B.A. 1893, i, 269.** *Ber.* **26**, 154-5. Constitution of the Iodides of Aromatic Sulfonic Acids. Discussed previous work on sulfonic iodides. See *B.A.* 1891, 718.

101 **Otto, R. B.A. 1893, i, 416.** *J. prakt. Chem.* [2] **47**, 367-74. Anilides of Benzene- and Paratoluene-sulfonic Acids. Phenyl- and Paratolyl-sulfone-oxysulfobenzene. Method of preparation given.

102 **Paterno, E. B.A. 1875, 637.** *Gazz. chim. ital.* **5**, 13-24. Researches on Some Derivatives of Natural and Synthetically Prepared Thymol. Studied thymol sulfonic acids prepared from thymol and sulfuric acid.

103 **Pauly, C. B.A. 1877, i, 312.** *Ber.* **9**, 1595. Benzenedisulfinic Acid. Reduce sulfonechloride with zinc and hydrochloric acid. Separate as zinc salt. Gives method of purification.

104 **Paysan, W. B.A. 1884, 453.** *Ann.* **221**, 360-4. Orthamidotoluene-para-thiosulfonic Acid. Prepares salts. Gives also the corresponding sulfinic acid.

105 **Perl, J. B.A. 1885, 391.** *Chem. Zentr.* **1884**, 468. Thiosulfonic Acids and Sulfinic Acids of Toluene. Thiosulfonic acid prepared from sulfonic chloride with ammonium sulfide. Thiosulfonic acid by action of acids gives sulfinic acid. Studied diamidotoluene-parasulfonic acid.

106 **Prunier, L. L. A. B.A. 1897, i, 504.** *Compt. rend.* **124**, 1028-9. Formation of Sulfonic Derivatives in the Preparation of Ether. Gives method of separation and purification from the residues when ether is prepared. Boils with water to decompose the ethyl hydrogen sulfate.

107 **Rad, S. v. B.A. 1872, 405.** *Ann. Chem. Pharm.* **161**, 218. Allylsulfonic Acid and Some of its Salts. Boiled neutral K sulfite dissolved in a small amount of H_2O with equal weight allyl I. Forms different salts of allyl sulfonate.

108 **Rathke, B. B.A. 1872, 388-92.** *Ann. Chem. Pharm.* **161**, 149-71. See p. 171-4 also. The Action of Potassium Sulfite on Bodies Containing CCl_4 . Long abstract given on this reaction. Substances such as chloral hydrate, trichloracetic acid, etc. are studied. See abstract or paper.

109 **Reinking, K., Dehnel, E., and Labhardt, H. B.A. 1905, i, 261.** *Ber.* **38**, 1069-80. Constitution of Aldehyde-sulfurous Acid and Hyposulfurous Acid.

110 **Rosenheim, A., and Sarow, W. B.A. 1905, i, 404.** *Ber.* **38**, 1298-1305. Salts of Alkylsulfurous and Alkylsulfonic Acids. Prepared methyl, ethyl, and propyl sulfites. Properties studied. Compared with sulfonic acids.

111 **Rosenheim, A. B.A. 1905, i, 508.** *Ber.* **1905**, 38, 2005. Formula for Aldehyde Hydrogen Sulfites. A correction. Compare Reinking, Dehnel and Labhardt (*B.A.* 1905, i, 261) and Rosenheim and Sarow (*B.A.* 1905, i, 404).

112 **Sabaneieff, A. B.A. 1886, 442.** *J. Russ. Chem. Soc.* **1886**, 35-49, 87-98. Action of Sulfuric Acid on Oleic Acid. Preparation of sulfohydroxystearic acid.

113 **Scheurer-Kestner. B.A. 1891, 542; 1891, 665.** *Compt. rend.* **112**, 158-60, 395-7. Turkey Red Oil. Studied sulfonated acid prepared from castor oil by H_2SO_4 . Complex composition but greater part recinoleosulfonic acid. Method of separation of free acid given in second paper (395-7).

114 **Schiller, R., and Otto, R. B.A. 1877, i, 312.** *Ber.* **9**, 1584-7. New Method of Preparing Benzenesulfinic and Toluenesulfinic Acids. Reduce sulfonechloride with zinc and hydrochloric acid. Zinc salts crystallized from water.

115 **Schiller, R., and Otto, R. B.A. 1877, i, 463.** *Ber.* **9**, 1638-9. Ethylbenzenesulfonate. Prepared from benzenesulfonechloride and sodium ethylate. It is a heavy yellowish oil, and is decomposed by boiling water.

116 **Schmidt, E. A. B.A. 1905, i, 23-8.** *Ann.* **337**, 37-121. Choline, Neurine, and Allied Compounds. Study of derivatives mainly for obtaining variation of physiological action. See abstract.

117 **Schober, W. B. B.A. 1904, i, 798.** *Am. Chem. J.* **32**, 165-7. Propane Trisulfonic Acid. Heated α, β, γ -tribrompropane with ammonium sulfite. Barium salt prepared.

118 **Schroeter, G. B.A. 1898, i, 614.** *Ber.* **31**, 2189-90. Action of Acetylene on Fuming Sulfuric Acid. Priority claim over work by Muthmann.

119 **Schroeter, G., and Herzberg, G. B.A. 1905, i, 851.** *Ber.* **38**, 3389-93. Methionic (Methanedisulfonic) Acid. Esters prepared of acid as well as other derivatives.

120 **Spring, W., and Winssinger, C. B.A. 1884, 1127.** *Ber.* **17**, 537-40. Action of Chlorine on Sulfonic Derivatives and Organic Oxysulfides. Continues work reported in *B.A.* 1882, 938 and 1883, 659.

121 **Spring, W., and Winssinger, C. B.A. 1888, 939.** *Bull. soc. chim.* **49**, 68-74.

Action of Chlorine on Sulfonic- and Oxythio-derivatives of Heptyl.
Compare *B. A.* 1884, 1127. Chlorinates heptylsulfonic acids in sunlight. No sulfuric acid formed.

122 Stebbins, J. H. *B. A.* 1893, i, 37. *J. Am. Chem. Soc.* 13, 155. Action of Sulfuric Acid on Quinol.
Preparation of sulfonic acid to increase solubility of quinol. Ba salt formed.

123 Stempnevsky, N. *B. A.* 1882, 487. *J. Russ. Chem. Soc.* 1882, 95-9. Normal Ethyl Sulfate.
Prepared ethyl sulfate from silver sulfate and ethyl iodide, and ethylisethionate from silver isethionate and ethyl iodide. Compares the two.

124 Tohl, A., and Muller, A. *B. A.* 1893, i, 408. *Ber.* 26, 1108-13. Behavior of Halogen Derivative of Ψ -Cumene Towards Sulfuric Acid.
Formation of sulfonic acids of substituted ψ -cumene.

125 Troeger, J., and Grothe, W. *B. A.* 1898, i, 263. *J. prakt. Chem.* [2] 56, 470-5. Naphthalene- and Orthotoluene-thiosulfonic Acids.
Prepared the thiosulfonates by action of alcoholic potassium sulfide on the sulfonic chloride.

126 Troeger, J., and Ewers, E. *B. A.* 1901, i, 171-5. *J. prakt. Chem.* [2] 62, 369-430. Arylthiosulfonates and Arylsulfinites of Diazo Compounds.
Compound of the type $\text{Ph} \cdot \text{N}_2 \cdot \text{S} \cdot \text{SO}_2$. Ph were prepared and studied. Abstract is long and many details given.

127 Troeger, J., and Meine, W. *B. A.* 1902, i, 599. *Ber.* 35, 2164-8. Salts of m-Benzeneedithiosulfonic Acid.
Prepared by gradually adding m-benzenedithiosulfonic chloride to a saturated aqueous solution of potassium disulfide. Silver and potassium salt described.

128 Troeger, J., and Volkmer, F. *B. A.* 1905, i, 89. *J. prakt. Chem.* [2] 70, 375-92. Action of Phenylhydrazine on Arylthiosulfonated Ethyl Acetoacetates.*

129 Twitchell, E. *B. A.* 1899, ii, 69. *J. Soc. Chem. Ind.* 16, 1002-4. Sulfuric Acid as a Reagent in the Analyses of Fatty Acids.
Oleic acid is sulfonated with 85% sulfuric acid. Describes methods of separation of fatty acids from sulfonated acids. Stearic and palmitic acids react with sulfuric acid of higher concentration.

130 Twitchell, E. *B. A.* 1900, i, 296. *J. Am. Chem. Soc.* 22, 22-6. Benzene-stereosulfonic Acid and Other Sulfonic Acids Containing the Stearyl Group.
Formed when a mixture of benzene and oleic acid is treated with excess of sulfuric acid, care being taken to avoid any excessive rise in temperature. Naphtyl and phenol derivatives also prepared.

131 Vaubel, W. *B. A.* 1900, i, 544. *Z. angew. Chem.* 13, 686-7. Removal or Substitution of Sulfonic Groups in Naphthalene by Nascent Chlorine.
Nascent bromine not effective. Nascent chlorine displaces sulfonic groups in ortho and para but not meta positions.

132 Vorlander, D., and Schroedter, M. *B. A.* 1903, i, 496. *Ber.* 36, 1490-7. Action of Sulfuric Acid and Acetic Anhydride on Dibenzylideneacetone.
Prepared sulfonic acid.

133 Weinland, R. F., and Lewkowitz, H. *B. A.* 1903, i, 808. *Ber.* 36, 2702-3. Benzenesulfonic Peroxide.
Prepared by shaking benzenesulfonic chloride with an aqueous solution of sodium peroxide at 0°. Becomes yellow above 20°.

134 Worstell, R. A. *B. A.* 1899, i, 18. *Am. Chem. J.* 20, 664-75. Sulfonation of the Paraffins.
Action of cold fuming sulfuric acid on hydrocarbon rapidly effects sulfonation when added at the boiling point. Monosulfonic acid formed with trace of di. For disulfonic acids pass SO_3 through boiling paraffins. Studied hexane, heptane and octane.

135 Worstell, R. A. *B. A.* 1899, i, 787. *Am. Chem. J.* 22, 164-7. Action of Sulfuric Acid on Nitroheptane.
A small quantity of nitroheptanesulfonic acid is formed when nitroheptane is added to 5 times its weight of well-cooled sulfuric acid.

136 Worstell, R. A. *B. A.* 1904, i, 1. *J. Am. Chem. Soc.* 25, 932-5. Action of Fuming Sulfuric Acid on Isoamyl Chloride.
Formation of a hydroxysulfonic acid.

137 Young, S. *J. Chem. Soc. Trans.* 1899, 172-5. Action of Chlorsulfonic Acid on the Paraffins and Other Hydrocarbons As a Means of Purifying the Normal Paraffins.
Useful in removing *iso* hydrocarbons.

CROSS REFERENCES

Group 2—15, 90, 92, 98; **Group 5**—12, 15, 81; **Group 6**—17, 22, 25, 33, 36, 41; **Group 7**—3, 12; **Group 8**—33; **Group 10**—3, 9, 22, 33, 50, 51, 55, 57, 62, 63, 84, 91, 92, 106, 111, 143, 162, 179, 180, 189, 191, 203, 206, 211, 226, 243, 272, 273, 280, 282, 283, 286, 289, 290, 291, 292, 293, 294, 295, 296, 299, 356, 360, 371, 373, 384, 394, 395, 397, 429, 431, 432; **Group 11**—44, 45; **Group 12**—11, 24, 28, 34, 67, 68; **Group 13**—15; **Group 14**—7, 109, 173; **Group 16**—1, 2, 8, 12, 15, 20, 21, 24, 25, 26; **Group 17**—8, 14, 25, 37, 43, 44, 49, 50, 52, 60, 63, 67, 80, 84; **Group 18**—71, 82, 92, 93, 94, 109, 127, 130, 133, 156, 157, 158, 178, 217; **Group 20**—27; **Group 21**—12; **Group 24**—1, 10, 17, 18, 21, 24, 25, 27, 29, 32.

GROUP 26

SULFINIC ACIDS, BOTH ALIPHATIC AND AROMATIC

1 **Basler Chemische Fabrik.** *B.A.* 1902, i, 715. *D.R.P.* 130, 119. Prep. aration of Aromatic Sulfinic Acids. Prepared by adding to the cold diazo solution a 40% solution of sodium hydrogen sulfite and excess alc. sulfuric acid containing a small quantity of cupric sulfate or other compound of Cu.

2 **Claesson, P.** *B.A.* 1877, ii, 296. *J. prakt. Chem.* [2] 15, 222-4. Ethyl Sulfinic Acid. From dry sodium ethylmercaptide and dry oxygen at 100°-120°. Gives reactions showing this product to be unstable, oxidizing to sulfonic acid.

3 **Fahlberg, C., and List, R.** *B.A.* 1887, 835. *Ber.* 20, 1596-1604. Ethylbenzoic sulfinide and Ethylorthosulfaminebenzoate.*

4 **Frerichs, G.** *B.A.* 1899, i, 795. *Arch. Pharm.* 237, 288-99. Action of Alkylsulfinates on Chloracetylurethanes and Chloracetocarbamides.*

5 **Gessner, E.** *B.A.* 1877, i, 315. *Ber.* 9, 1500-5. On the Naphthalene Sulfinic Acids. Reduce sulfonechloride with sodium amalgam. Studied sulfinic acid.

6 **Hantzsch, A.** *B.A.* 1898, i, 365. *Ber.* 31, 636-42. Diazocyanides and the Reaction of Diazo Compounds with Benzenesulfinic Acid.*

7 **Heiduschka, A.** *C.A.* 1910, 2940. *J. prakt. Chem.* 81, 320-7. p-Toluenesulfinic Acid. The preparation of the acid and a number of its derivatives, described. No new results given.

8 **Heiduschka, A., and Langkammerer, H.** *C.A.* 1914, 1093. *J. prakt. Chem.* 88, 425-42. p- and o-Toluenesulfinic Acids. The preparation and properties of these compounds and certain of their derivatives are given.

9 **Hilditch, T. P., and Smiles, S.** *C.A.* 1909, 538. *Ber.* 41, 4113-6. Chlorides of Aromatic Sulfinic Acids. Prepared by action of thionylchloride on corresponding sulfuric acid at ordinary temperatures. SO_2 and HCl liberated. Chlorides very active and fume in moist air.

10 **Hinsberg, O., and Himmelschein, A.** *B.A.* 1896, i, 684. *Ber.* 29, 2019-23. Benzenesulfinic Acid as a Reagent.*

11 **Hinsberg, O.** *B.A.* 1898, i, 140. *Ber.* 30, 2803-5. Benzenesulfinic Acid as a Reagent. Reacts with tetramethyldiamidobenzhydrol.

12 **Jesurin, J. A.** *B.A.* 1893, i, 715. *Ber.* 26, 2286-98. Action of Phosphorus Pentachloride on Orthobenzoic sulfinide. Discusses reaction products formed.

13 **Knoevenagel, E., and Polack, L.** *C.A.* 1909, 174. *Ber.* 41, 3323-31. Sulfinic Anhydrides. Formed by action of AcOH and concentrated sulfuric acid on sulfinic acids. Anhydrides of sulfinic acids in *Ber.* 41, 3315-22 and *C.A.* 1909, 173 were prepared.

14 **Koenigs, W.** *B.A.* 1878, 573. *Ber.* 11, 615-9. Action of Nitrous Acid on Benzenesulfinic Acid. 1 mol. of benzenesulfinic acid reacts with 2 mol. of benzene sulfonic acid to form $(\text{C}_6\text{H}_5\text{SO}_2)_2\text{HNO}$.

15 **Krishna, S., and Das, B.** *C.A.* 1928, 1134. *Quart. J. Indian Chem. Soc.* 4, 367-74. Gas Volumetric Estimation of $-\text{SOOH}$ in Organic Sulfinic Acids. Method of procedure is given.

16 **Krishna, S., and Singh, H.** *C.A.* 1928, 1325. *J. Am. Chem. Soc.* 50, 792-8. Estimation of $-\text{SOOH}$ (Sulfinic) Group and Fe^{+++} . The reaction between RSO_2H and Fe^{+++} gives $(\text{RSO}_2)_2\text{Fe}$ quantitatively. This reaction furnishes a method of estimation of the $-\text{SOOH}$ group.

17 **Kurbatow, A.** *B.A.* 1873, 873. *Ber.* 6, 563. Preparation of α -Sulfopropionic Acid. Chlorosulfuric acid and propionic acid form α -sulfopropionic acid on heating. This is also prepared by treating ethylchlorpropionate with ammonium sulfite.

18 **Limprecht, H.** *B.A.* 1893, i, 168. *Ber.* 25, 3477. Nitrosulfinic Acids. All nitrosulfinic acids examined give a blue color with phenol and sulfinic acids similar to nitroso compounds. Metanitrobenzenesulfonyl bromide also gives a blue coloration with phenol and sulfuric acid, but the sulfochloride does not.

19 **Meyer, E. von.** *B.A.* 1903, i, 808. *J. prakt. Chem.* [2] 68, 263-93. p-Toluenesulfinic Acid. Prepared many derivatives containing nitrogen as side chains.

20 **Otto, R., and Rossing, A.** *B.A.* 1885, 1231. *Ber.* 18, 2493-2509. Constitution of the Sulfinic Acids. Ethylbenzenesulfinate was prepared but not obtained pure. It is very quickly decomposed by exposure to moisture or air. It is insoluble in water, but soluble in organic solvents.

21 **Otto, R., and Otto, W.** *B.A.* 1888, 841. *Ber.* 21, 1691-7. Action of Alkaline Sulfinates on Trihalogen Substituted Hydrocarbons. See *B.A.* 1888, 482 and 483. CHCl_3 and sodium benzenesulfinate do not react when heated in sealed tubes at 160° for 8 hours. See abstract.

22 **Otto, R., and Rossing, A. B.A. 1892**, 623. *Ber.* **25**, 230-3. Tautomerism of Sulfinic Acids.
In first part of paper reply to some criticisms of Baumann. See abstract.

23 **Otto, R. B.A. 1893**, i, 270. *Ber.* **26**, 308-10. Preparation of Pure Ethylbenzenesulfinate and Ethylparatoluene-sulfinate.
Gives method of preparation.

24 **Otto, R., and Rossing, A. B.A. 1893**, i, 343. *J. prakt. Chem.* [2] **47**, 152-72. Ethereal Sulfinates.
Gives preparation of methyl- and ethyl-arylsulfinates. Some chemical properties given.

25 **Otto, R., and Zuschlag, G. B.A. 1893**, i, 344. *Ber.* **26**, 430-5. Chemical Behavior of Ethereal Salts of Sulfinic Acids.
Gives decomposition with H_2S and aqueous solution of potassium sulfide. Gives products formed.

26 **Thomas, J. C.A. 1909**, 2119. *J. Chem. Soc.* **95**, 342-5. Isolation of the Aromatic Sulfinic Acids.
Isolated by precipitation as ferrie salt with $FeCl_3$ in strongly acid solution.

27 **Whalen, H. F., and Jones, L. W. C.A. 1925**, 1699. *J. Am. Chem. Soc.* **47**, 1353-7. Action of Hydroxylamine upon Sulfinic Acids and their Derivatives.
See article.

CROSS REFERENCES

Group 2—60; Group 3—40; Group 5—19, 96; Group 6—12, 13, 31, 40, 41; Group 7—14; Group 8—33; Group 10—9, 23, 51, 56, 82, 88, 152, 162, 189, 280, 285, 287, 288, 289, 290, 291, 292, 294, 295, 296, 299, 326, 360, 370, 371, 386; Group 11—23, 26, 27, 28, 31, 32, 33, 34, 44, 45; Group 12—35, 42, 49, 50, 68; Group 13—14; Group 14—63, 82, 96, 210; Group 16—1, 2, 8, 10, 11, 15, 16, 21, 24, 26; Group 17—5, 6, 21, 27, 28, 32, 36, 37, 38, 39, 43, 47, 48, 53, 59, 61, 62, 64, 65, 66, 67, 71, 72, 76, 78, 80, 81, 90, 94, 95, 96, 97, 98, 99, 100, 103; Group 18—217; Group 20—27; Group 25—8, 35, 76, 77, 94, 95, 96, 97, 103, 104, 105, 114, 126.

GROUP 27

SULFATES AND A FEW SULFITES

1 **Baumann, E. B.A. 1879**, 148. *Ber.* **1**, 1907, 16. Hydrogen Phenyl Sulfate and Similar Derivatives of Phenols.
Prepared potassium phenyl sulfate. Crystallizes from alcohol. Decomposes on exposure to moist air. Decomposed by strong mineral acids at gentle heat, very slowly by boiling acetic acid, and stable in alkaline solution. At 150° - 160° rearranges to phenolsulfonic acid. Studied other sulfates also.

2 **Berthelot, B.A. 1873**, 869. *Bull. soc. chim.* [2] **19**, 295-300. Sulfovinic Acid and its Salts.
Studied action of sulfuric acid upon alcohol and the effect of water upon sulfonates.

3 **Berthelot, M. B.A. 1876**, 59. *Compt. rend.* **132**, 243-9. Action of Monohydrated Sulfuric Acid on Alcohols.
Heat evolved in decomposition of various ethereal salts of sulfuric acid by water measured.

4 **Berthelot, B.A. 1894**, i, 393. *Compt. rend.* **118**, 1009-13. Isomerides of Propylene and their Sulfates.
Propylene and trimethylene are both absorbed immediately by concentrated sulfuric acid at ordinary temperature forming normal sulfates. Discusses stability of sulfates. Ethylene is very slowly absorbed by sulfuric acid. Isobutylene yields sulfate gradually decomposed by water.

5 **Berthelot, B.A. 1894**, i, 433. *Compt. rend.* **118**, 1115-23. Trimethylene and Propylene and a New Class of Hydrocarbons: Dynamic Isomerism.
Propylene and sulfuric acid develop 16.7 cal. For trimethylene value is 25.5 cal. See abstract or original for energy relationships of propylene and trimethylene with bromine, formation, etc.

6 **Biron, E. B.A. 1899**, i, 408. *J. Russ. Chem. Gess.* **29**, 697-8. *Chem. Zentr.* **1898**, i, 885. Decomposition of Barium Isobutylic Sulfate.
Decomposes at 130° to form two-thirds isobutylene and one-third pseudobutylene.

7 **Blacker, M. B. B.A. 1901**, i, 577. *Chem. News* **83**, 303-4. Preparation of Dimethyl Sulfate.
From ether dissolved in sulfuric acid at 160° . Yield 21%.

8 **Baggesgaard-Rasmussen, H. C.A. 1919**, 3191. *Ber.* **52B**, 1069-78. Saponification of Diethyl Sulfite.*

9 **Bouchardat, G. B.A. 1881**, 1114. *Compt. rend.* **93**, 316-8. Action of Sulfuric Acid on Bromamylene.
Conc. H_2SO_4 and bromamylene give amyl bromide and a substance having the properties of a ketone. With H_2SO_4 (1:1) a substance having the properties of an alcohol is produced.

10 **Bouchardat, G., and Lafont, J. B.A. 1898, i, 442.** *Compt. rend.* **125**, 111-114. Action of Sulfuric Acid on 1-Terebenthene.
Forms potassium terebenthene sulfate.

11 **Boulin, C., and Simon, L. J. C.A. 1920, 175.** *Compt. rend.* **169**, 618-20. Action of Stannic Chloride on Dimethyl Sulfate.
Two steps occur in the reaction. In the first place MeCl and an alkali sulfate are formed. Complex products are also formed.

12 **Boulin, C., and Simon, L. J. C.A. 1920, 1658.** *Compt. rend.* **170**, 392-4. Action of Water on Dimethyl Sulfate.
The reaction proceeds as follows.
 $\text{Me}_2\text{SO}_4 + \text{H}_2\text{O} \rightarrow \text{HOSO}_2\text{OMe} + \text{MeOH}$

13 **Bunte, H. B.A. 1874, 353.** *Ann. Chem. Pharm.* **170**, 305-30. On Aldehyde Sulfites and the Action of Sodium Sulfite on Ethidene Dichloride.
See abstract or paper.

14 **Bushong, F. W. B.A. 1903, i, 732.** *Am. Chem. J.* **30**, 212-24. Esters of Sulfuric Acid and of Chlorosulfonic Acid.
Studied action of ethylchlorosulfonate on sodium ethoxide, isoamyloxide, isobutoxide, and isopropoxide.

15 **Buttlerow and Gorgainow. B.A. 1873, 747.** *Ber.* **6**, 196. Solution of Ethylene in Sulfuric Acid.
Strong sulfuric acid at 160° - 170° absorbs ethylene perfectly.

16 **Chapman, Ernest T. B.A. 1870, 23,** 415-23. On the Production of the Sulfates of the Alcohol Radicals from the Nitrites by the Action of Sulfurous Acid.
Studies reaction of amyl nitrite and sulfurous acid to form diamylsulfate and oxides of nitrogen (NO_x).

17 **Claesson, P. B.A. 1879, 775-7.** *J. prakt. Chem.* **[2] 19**, 231-65. Methyl and Ethyl Sulfates.
Prepared by action of sulfur monochloride on methyl or ethyl alcohol. See abstract for discussion of properties.

18 **Claesson, P. B.A. 1879, 1033-5.** *J. prakt. Chem.* **[2] 20**, 1-34. Ethereal Sulfates of Polyhydric Alcohols and of Carbohydrates.
Prepared acid sulfate by use of sulfuric monochloride. Prepared various alkyl acid sulfates and salts. Discusses solubilities and some chemical reactions.

19 **Claesson, P., and Lundvall, C. F. B.A. 1881, 240.** *Ber.* **13**, 1699-1705. Action of Ammonia and Amines on Ethyl and Methyl Sulfates.
See Dumas and Peligot (*Ann. chim. phys.* **58**, 32) and Strecker (*Ann.* **75**, 45). Reaction between methyl or ethyl sulfates and ammonia or amines is very energetic. Ammonia in excess forms with methyl sulfate, methylamine methyl sulfate. Ethylamine reacts with dimethyl sulfate but amines produced cannot be separated. See abstract.

20 **Colombano, A. C.A. 1908, 1720.** *Att. accad. Lincei*, **16** (2) 547-51. Etherification of Azo-derivatives of Hydroxy Acids By Means of Dimethyl Sulfate.
When 1-hydroxy 4-benzeneazobenzoic acid in alk. solution is treated with Me_2SO_4 the known dimethyletherester is obtained, also the new monomethylester.

21 **Delepine, M. B.A. 1900, i, 130.** *Compt. rend.* **129**, 831-3. Methylene Sulfate or Sulfuric Methylal.
Obtained by dissolving methylal in fuming sulfuric acid. Soluble in acetone. Reactions studied. Heat of combustion measured.

22 **Delepine, M. B.A. 1900, i, 163.** *Bull. soc. chim.* **[3] 21**, 1059-61. Action of Methylene Sulfate on Benzyl-alcohol.
Prepared dibenzylformal.

23 **Forrand, de. B.A. 1884, 989.** *Compt. rend.* **98**, 1537-9. Potassium and Barium Glyoxal Hydrogen Sulfites.
Heats of formation measured.

24 **Forrand, de. B.A. 1885, 648.** *Compt. rend.* **100**, 642-4. Glyoxal Ammonium Hydrogen Sulfite.
Preparation. Analogous to the other glyoxal bisulfites.

25 **Fritzsche, P. B.A. 1898, i, 3.** *Z. anal. Chem.* **36**, 303-6. Manufacture of Ethyl Hydrogen Sulfate from Gases Containing Ethylene.
Remove homologs of ethylene and any tar by passing through dilute (under 80%) sulfuric acid at 70° - 80° . Gas is then heated to 110° - 120° and passed into an absorption apparatus. Apparatus described. Thus 50% to 60% ethyl hydrogen sulfate is obtained.

26 **Geitel, A. C. B.A. 1888, 578.** *J. prakt. Chem.* **[2] 37**, 53-90. Action of Strong Sulfuric Acid on Oleic Acid and Triolein.
Formation of a sulfate (?).

27 **Graebe, C. B.A. 1905, i, 678.** *Ann. 340*, 244-9. Esterification By Means of Methyl Sulfate.
Gives historical résumé then some experimental work.

28 **Groves, C. E. B.A. 1874, 636-41.** Note on the Preparation of Ethyl Chloride and its Homologs.
Using ethyl sulfuric acid and salt or HCl .

29 **Gustavson, G., and Demjanoff, N. B.A. 1889, 29.** *J. prakt. Chem.* **[2] 38**, 201-7. Isoallylene.
When passed into strong H_2SO_4 it is absorbed and on dilution with H_2O and addition of KOH, acetone separates.

30 **Guvot, J., and Simon, L. J. C.A. 1920, 1303.** *Compt. rend.* **169**, 435-7. Action of Dimethyl Sulfate and Alkali Methyl Sulfates on Dry Alkali Chlorides and Bromides.*

31 **Guvot, J., and Simon, L. J. C.A. 1920, 1524.** *Compt. rend.* **168**, 1054-6.

Action of Heat on the Methyl Sulfates of the Alkali and Alkaline Earths.*

32 **Guvot, J., and Simon, L. J.** *C. A.* 1920, 1525. *Compt. rend.* 168, 1204-6. The Action of Dimethyl Sulfate on the Alkali and Alkaline Earths.*

33 **Harrison, T. W., and Perkin, F. M.** *C. A.* 1908, 1617. *Analyst* 33, 2-11; *J. Soc. Chem. Ind.* 27, 114. Action of Dimethyl Sulfate upon Oils of the Aromatic and Aliphatic Series. No abstract given. See *C. A.* 1908, 978.

34 **Honig, M., and Schubert, S.** *B. A.* 1886, 44. *Monatsh.* 6, 708-49. Sulfates of Some Carbohydrates. If sulfuric acid acts on cellulose at temperatures varying from 7°-40° and product is treated with barium carbonate, a substance with the same per cent of barium but differing rotatory power is obtained. Salts of varying composition but the same rotatory power can be made by varying the concentration of acid. Starch is acted upon similarly but more slowly. When the hydrogen sulfates are boiled with alcohol they lose sulfuric acid, leaving modified forms of cellulose and starch.

35 **Houben, J., and Arnold, H. R.** *C. A.* 1908, 2372. *Ber.* 41, 1565-80. Chloromethyl Sulfate. Action on Amino Groups. React to form methylene amino compounds. Various compounds are given.

36 **Kohler, H.** *B. A.* 1879, 137. *Ber.* 11, 1926-8. Action of Ammonium Sulfate on Barium Ethyl Sulfate. On dry distillation gives small amount ethylamine, diethyl sulfate, and some decomposition.

37 **Kohler, H.** *B. A.* 1879, 137. *Ber.* 11, 1929-32. Decomposition of Ethyl Sulfates by Gaseous Hydrochloric Acid. Formation of ethyl chloride.

38 **Kremann, R.** *B. A.* 1907, ii, 157. *Monatsh.* 27, 1265-73. Kinetics of Formation of Ethers by the Action of Absolute Alcohol on Alkyl Sulfates. Use of absolute alcohols on alkyl sulfates. See abstract.

39 **Lagermark, H., and Eltekoff, A.** *B. A.* 1877, ii, 583. *Ber.* 10, 637-41. Action of Sulfuric Acid on Acetylene. Dissolve acetylene in sulfuric acid and then distil with water, giving crotonaldehyde.

40 **Lagermark, G., and Eltekoff, A.** *B. A.* 1879, 780. *Ber.* 12, 693-4. Action of Sulfuric Acid on Acetylene. Formation of crotonaldehyde. Polemical.

41 **Lebedew, B. A.** 1876, i, 894. *Ber.* 8, 767. Polymerization of Amylene. Diamylene formed by sulfuric acid.

42 **Levaillant, R.** *C. A.* 1929, 4669. *Compt. rend.* 188, 261-3. Diisopropyl Sulfate and Dipropyl Sulfate. Preparation and properties given.

43 **Limousin.** *B. A.* 1872, 853. *J. Pharm. chim.* [4] 15, 271; *Pharm. J. Trans.* [3] 2, 985. Preparation and Purgative Properties of Sodium Sulfovinate. Prepare 1 kg. H_2SO_4 , 1 kg. EtOH. Heat 5 days at 23°, dilute with 5 l. of water, saturate with $BaCO_3$, decant and filter. Precipitate filtrate with Na_2CO_3 , decant, filter, evaporate at 100° to sp. gr. 1.33, and allow to crystallize (about 1 kg.) $EtNaSO_4 \cdot H_2A$. Soluble in alcohol, water. Three times more efficient than Na_2SO_4 .

44 **Ludwig, E.** *B. A.* 1892, 951. *Ber.* 25, 1409-10. Action of Sulfuric Acid on Methyl ethyl acraldehyde. Formation of a hexenylsulfuric acid.

45 **Mazurowska, M.** *B. A.* 1876, 61-3. *J. prakt. Chem.* [2] 13, 158-75. Sulfuric Ethers. Studied ethyl, methyl, phenyl, nitrophenyl, and thymol sulfates. Read abstract or original.

46 **Meuler, M.** *C. A.* 1921, 509. *Chem. Met. Eng.* 23, 833. Precautions in the Use of Dimethyl Sulfate. Various precautions given.

47 **Muller, M.** *B. A.* 1873, 841. *Ber.* 6, 227-31. Contributions to the Knowledge of Monochlorsulfuric Acid. Studied product formed between ethylene and chlorsulfuric acid. See abstract.

48 **Muller, M.** *B. A.* 1874, 360. *Ber.* 6, 1441-7. Oxypropanesulfonic Acids, and the Combination of Acrolein with the Alkaline Bisulfites. See M. Muller (*B. A.* 1874, 353).

49 **Nef, J. U.** *B. A.* 1901, i, 626. *Ann.* 318, 1-57. Dissociation of the Alkyl Nitrates, Sulfates, and Haloids. Prepared alkyl sulfates and studied their decomposition on heating. See abstract or original.

50 **Nietzki, R.** *B. A.* 1882, 736. *Ber.* 15, 305-6. Naphthyl Sulfuric Acid. β -Naphthol and sulfuric acid form $C_{10}H_7SO_3H$. By heating sodium salt of this acid with sodium ethyl sulfate, ethyl β -naphthyl is obtained.

51 **Orlowsky.** *B. A.* 1875, 875. *Ber.* 8, 332-5. Action of Chlorhydrosulfuric Acid on Alcohols. Prepared diethyl sulfate. When pure faint yellow liquid soluble in water to form ethyl sulfuric acid. Miscible in ether and benzene but is precipitated by an excess. Prepared methyl, propyl, butyl, and amyl sulfates. Thinks he prepared diphenyl sulfate. See Kekulé (*Z. f. Chem.* 1867, 197).

52 **Osipoff.** *B. A.* 1875, 877. *Ber.* 8, 542. Action of Sulfuric Acid on Amylene. Dilute sulfuric acid (sp. gr. 1.67) carefully mixed with amyrene (b. p. 32°-40°) gives amyl alcohol. With more dilute acid, a different alcohol obtained.

53 **Osipoff.** *B. A.* 1876, i, 544. *Ber.* 8, 1240-4. Amyl Alcohol from Amylene and Sulfuric Acid. Treats amyrene with sulfuric acid of sp. gr. 1.545 at 20° and gets amyl alcohol, b. p. 102°-105°.

54 **Passon, M.** *B. A.* 1891, 1118. *Ber.* 24, 1678-82. Alkylation of Secondary

and Primary Bases by Potassium Alkyl Sulfates.
Prepared tertiary amines from secondary amines with potassium methyl sulfate or potassium ethyl sulfate.

55 **Phipson, T. L. B.A. 1875, 747.** *Chem. News* 31, 75. Observations on the Production of Nitrous Ether by Means of Sulfovinic Acid.
Reaction violent.

56 **Purgold, T. v. B.A. 1873, 1216.** *Ber.* 6, 502. Action of Ethyl Chloride on Sulfuric Anhydride.
Chief product is chlorosulfuric ether.

57 **Ramsay, W., and Rudorf, G. Proc. Chem. Soc. 1900, 177.** The Action of Heat on Ethyl Sulfuric Acid.
Yields SO_2 , CO_2 , CO , and C_2H_4 . Discusses reaction and temperature effect.

58 **Ray, P. C., and Neogi, P. C.A. 1907, 178.** *Proc. Chem. Soc.* 22, 259. On the Interaction of the Alkyl Sulfates with the Nitrites of the Alkali Metals and Metals of the Alkaline Earths.
Interaction of the Na, K, Ba, and Ca salts of EtSO_2OH and the nitrites of the alkali metals gave nitrite and nitroethane.

59 **Renard, A. B.A. 1880, 24-8.** *Ann. Chem. Phys.* [5] 16, 289-337. Oxidation of Alcohols by Electrolysis.
Electrolyzed methyl hydrogen sulfate and found formic acid and trioxymethylene. Ethyl alcohol gave no aldehyde either. See abstract.

60 **Rosenheim, A., and Lebknecht, O. B.A. 1898, i, 290.** *Ber.* 31, 405-14. Alkylic Sulfites.
Prepared sulfites and studied their stability. See abstract or original.

61 **Schall, C. B.A. 1892, 970.** *Ber.* 25, 1490. Sodium Phenyl Sulfite.
Pass SO_2 into sodium phenoxide.

62 **Scholvién, L. B.A. 1891, 410.** *Apoth. Ztg.* 5, 607-8; *Chem. Zentr.* 1890, ii, 782-3. Behavior of Ethyl Ether with Sulfuric Acid; Separation of Ethyl Ether from Ethyl Bromide.
On mixing at ordinary temperature no chemical combination and dilution with water causes separation. If the mixture is heated at 100° for some time (30 hours) much ethyl hydrogen sulfate and a little diethyl sulfate are formed. By heating strongly, sulfuric anhydride, ethylene, and water are formed. Purify ethyl bromide by refluxing with equal weight of sulfuric acid.

63 **Smith, J. B.A. 1888, 869.** *Z. physiol. Chem.* 12, 419-33. Substance Containing Sulfur Found in Cruciferous Plants.
Ethereal hydrogen sulfates.

64 **Spiegel, L. B.A. 1896, i, 332.** *Chem. Ztg.* 19, 1423. Isopropyl Hydrogen Sulfate.
Prepared as isopropyl barium sulfate.

65 **Szymanski, F. B.A. 1886, 43.** *Ann. 230*, 43-50. Allyl Sulfuric Acid.
See Cahours and Hoffman (*Ann.* 102, 293) and Bellstein and Weigand (*B. A.* 1885, 740). Allyl alcohol is slowly added to sulfuric acid (1 vol.; 1 vol. water). Salts prepared—Ba, Sr, Ca, Pb, Mg, ferrous.

66 **Taylor, J. N. C.A. 1927, 816.** *Ind. Eng. Chem.* 19, 76-7. Diethyl Sulfate in the Examination of Hydrocarbon Oils.
Results comparable with those of sulfonation may be obtained by use of (C_2H_5)₂ SO_4 in differentiating paraffin and naphthene from aromatic and unsaturated hydrocarbons.

67 **Ullmann, F., and Wenner, P. B.A. 1900, i, 619.** *Ber.* 33, 2476-7. Dimethyl Sulfate as an Alkylating Agent.
Replaces methyl iodide.

68 **Ullmann, F. B.A. 1903, i, 394.** *Ann. 327*, 104-19. Methyl Sulfate as an Alkylating Agent.
Studied aromatic amines largely.

69 **Valenta, E. B.A. 1906, ii, 310.** *Chem. Ztg.* 30, 266-7. Use of Methyl Sulfate in the Estimation of Tar Oils in Admixture with Resin Oils or Mineral Oils.
Methyl sulfate used to dissolve true tar oils. See abstract.

70 **Verley, A. B.A. 1901, i, 143.** *Bull. soc. chim.* [3] 25, 46-9. Aryl Hydrogen Sulfates.
A general method for the preparation consists in adding the phenol to a cooled mixture of pyridine and chlorosulfonic acid in CS_2 , removing the CS_2 by distillation and decomposing the double sulfate of pyridine and the phenol thus produced with KOH solution. Prepared thus phenyl, thymyl, geranyl, benzyl and β -naphthyl sulfates.

71 **Villiers, A. B.A. 1880, 797.** *Compt. rend.* 90, 1291-2. Preparation of Neutral Ethyl Sulfate.
Distill a mixture of sulfuric acid and alcohol in vacuum very slowly.

72 **Villiers, A. B.A. 1903, i, 599.** *Compt. rend.* 136, 1452-3. Esterification of Sulfuric Acid.
Compare *B. A.* 1880, 796. Mixture of ethyl alcohol and sulfuric acid allowed to remain at ordinary temperatures for 25 years yielded 22.2% ester, same as found after 221 days at 44° and 154 hours at 100°. See abstract for comparisons.

73 **Walden, P. B.A. 1906, ii, 149.** *Z. physik. Chem.* 54, 131-230. Organic Solvent and Ionizing Media, II.
Studied among other organic solvents, methyl and ethyl sulfate and ethyl sulfite.

74 **Weinland, R. F., and Kappeller, G. B.A. 1901, i, 309.** *Ann.* 315, 357-78. Addition of Hydrogen Fluoride to Salts of Ethyl Sulfuric Acid and Certain Sulfonic Acids.*

75 **Zohlen, O. B.A.** 1903, i, 118. *J. prakt. Chem.* [2] 66, 387-400. Action of Methyl Sulfate on Michler's Ketone and Auramine.

Forms hexamethyldiaminobenzophenone-dimethosulfate and methylauraminemethosulfate.

CROSS REFERENCES
Group 6—18; **Group 7**—1, 4, 5, 6; **Group 8**—4; **Group 10**—175, 183, 212, 266, 423; **Group 12**—8, 14; **Group 14**—14, 152; **Group 17**—62, 82; **Group 23**—59; **Group 25**—7, 10, 20, 29, 33, 37, 38, 49, 50, 83, 93, 106, 110, 111, 123.

GROUP 28

THIOSULFATES

1 **Bunte, H. B.A.** 1874, 770. *Ber.* 7, 646-8. On the Constitution of Hypo-sulfurous (Thiosulfuric Acid).

Discusses reaction of the Na thiosulfate and ethyl bromide to form ethyl thiosulfate. Reactions given.

2 **Dybowski, B., and Hantzsch, A. B.A.** 1902, i, 249. *Ber.* 35, 268-71. Supposed Isomerism of Diazothiosulfonates.*

3 **Purgotti, A. B.A.** 1890, 1419. *Gazz. chim. ital.* 20, 24-32. Organic Sulfuretted Compounds.

Studied action of sodium thiosulfate on benzyl chloride.

4 **Purgotti, A. B.A.** 1892, 1418. *Gazz. chim. ital.* 22, 416-26. New Thiosulfates.

Prepared metal thiosulfate of allyl, isopropyl, ethylene, hydroxyethyl, aceto, and ethylaceto. Studied decomposition.

5 **Troeger, J., and Linde, O. B.A.** 1900, i, 515. *Arch. Pharm.* 238, 4-8. Alkyl Thiosulfonates of Organic Basis. Salts with alkaloids.

6 **Willcox, O. W. B.A.** 1905, i, 45. *Am. Chem. J.* 32, 446-76. Reactions of Ethyl Chlorosulfonate.

Studied alkylating reaction of it with sodium alkyl oxides and with aniline. See abstract.

CROSS REFERENCES

Group 3—49; **Group 6**—16; **Group 10**—40, 152, 285, 394; **Group 11**—35, 47; **Group 12**—8, 33, 70, 71, 74, 75, 76, 85; **Group 14**—165; **Group 17**—89; **Group 21**—28.

GROUP 29

THIOCYANATES

1 **Baeyer, A. von, and Villiger, V. B.A.** 1904, i, 308. *Ber.* 37, 597-612. Dibenzylideneacetone and Triphenylmethane, IV.

Prepared p-nitrotriphenylcarbinyl thiocyanate.

2 **Billeter, O. B.A.** 1876, ii, 184. *Ber.* 8, 820. Action of Allyl Iodide on Potassium Sulfocyanate.

Prepared allyl thiocyanate.

3 **Blankenhorn, E. B.A.** 1877, ii, 423. *Ber.* 10, 445-8. Action of Nascent Thiocyanic Acid on Alcohol.

Ethyl alcohol and thiocyanic acid give product of unknown constitution.

4 **Dixon, A. E. J. Chem. Soc. Trans.** 1888, 411-21; **1889**, 300-5; 618-27. The Action of Isothiocyanates on the Aldehyde-ammonias.

Found numerous condensation products between various isothiocyanates and aldehyde-ammonias.

5 **Doran, R. E. Proc. Chem. Soc.** 1904, 20. The Tautomeric Character of Acyl Thiocyanates. A Preliminary Note.

Dependent upon temperature as to its reaction with aniline.

6 **Dixon, A. E., and Hawthorne, J. J. Chem. Soc. Trans.** 1905, 468-81. The Tautomerism of Acetyl Thiocyanate.

Discusses behavior as acetyl—NCS or —CNS. See paper.

7 **Dixon, A. E. J. Chem. Soc. Trans.** 1906, 892-912. The Chemistry of Organic Acid "Thiocyanates" and their Derivatives.

Behavior as though —SCN and —NCS present.

8 **Dixon, A. E., and Taylor, J. C.A.** 1908, 1826. *Proc. Chem. Soc.* 24, 73; *J. Chem. Soc.* 93-4, 684-700. The Con-

stitution of "Thiocyanates" Containing an Electronegative Group. Examination of acylthiocarbimides shows NCS group to have same refraction value as in hydrocarbon thiocarbimides.

9 Dünner, J. B.A. 1876, ii, 204. *Ber.* 9, 465. Action of Carbon Disulfide on Orthoamidophenol. Alcoholic solution of orthoamidophenol heated with excess CS_2 and stream of hydrogen forms compound corresponding to sulfonycyanate with elimination of hydrogen sulfide. HCl at 170° decomposes it. Other reactions given.

10 Cattermann, L., and Haussknecht, W. B.A. 1890, 749. *Ber.* 23, 738-9. Formation of Thiocyanates from Amido Compounds. Aromatic compounds studied.

11 Gerlich, G. B.A. 1875, 1019. *Ber.* 8, 650-3. Isopropyl and Allyl Sulfocyanates. Prepared from iodide and potassium sulfocyanates.

12 Gutmann, A. C.A. 1908, 1941. *Z. anal. Chem.* 47, 294-303. A Titrimetric Method for Thiosulfonates. KCN in presence of alkali reacts on thiosulfonates to give $KCNS$, RSO_2MS plus $KCN = RSO_2M$ plus $KCNS$. The $AgNO_3$ and NH_4CNS method is then applied. Sulfonates, sulfonates, alkyl sulfates, sulfates, and sulfites do not interfere.

13 W. R. H. B.A. 1877, i, 195. *Chem. News* 34, 80. Pseudosulfocyanogen (CNSH). Treat sulfocyanates in alkaline salts with chlorine, bromine, or iodine and a yellow, water-insoluble compound is formed. Suggested as a pigment for water or oil colors.

14 Hantzsch, A. B.A. 1893, i, 64. *Ber.* 25, 3282-6. Thiocyanacetone. Refutation of Teberniac's criticisms (B.A. 1892, 1245).

15 Hantzsch, A. R., and Hirsch, B. B.A. 1896, i, 428. *Ber.* 29, 947-52. Intramolecular Rearrangement of Diazo-nium Thiocyanates. Formation of SCN on benzene in para position by adding HCl to the diazonium thiocyanate.

16 Hawthorne, J. J. *Chem. Soc. Trans.* 1906, 556-67. The Constitution and Properties of Acyl Thiocyanates. Studied behavior with aromatic amines. Behaved as though —SCN and —NCS group in equilibrium.

17 Henry, L. B.A. 1875, 57. *J. prakt. Chem.* [2] 9, 464-8. On Sulfocyanocarbonic Acid and its Derivatives. Ethyl chlorocarbonate reacts with potassium or ammonium sulfocyanate to form sulfocyanocarbonic ether. Substance studied.

18 Hirsch, B. B.A. 1898, i, 473. *Ber.* 31, 1253-68. Halogenized Diazonium Thiocyanates and their Rearrangement into Thiocyanodiazonium Salts.*

19 Hoffman, A. W. B.A. 1871, 137. *Z. f. Chem.* [2] 7, 29. On a New Mode of Forming Isonitriles. Allyl sulfocyanate + 1 mol. Et_3P forms a compound which on heating gives Et_3P ; S and C_6H_5CN . Methyl, ethyl and amyl behave in same manner.

20 Hoffman, A. W. B.A. 1871, 140. *Z. f. Chem.* [2] 7, 31. On the Action of Acetic Acid on Phenyl Sulfocyanate. Phenyl sulfocyanate heated with acetic acid at 130° - 140° for some hours under pressure. H_2S and CO_2 escape on opening tube. Acetanilide is formed.

21 James, J. W. *J. Chem. Soc. Trans.* 1887, 268-74. The Action of Chlorine on Organic Thiocyanates. I, Methyl Thiocyanate. From methyl thiocyanate and dry chlorine obtained cyanuric chloride and thionyl chloride.

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23 Klason, P. B.A. 1887, 1025. *J. prakt. Chem.* [2] 36, 57-64. Action of Acids on Thiocyanic Acid.*

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25 Lecher, H., and Goebel, A. C.A. 1922, 3888. *Ber.* 55B, 1483-95. Sulfur Thiocyanate.*

26 Meyer, V., and Wurster, C. B.A. 1873, 1224. *Ber.* 6, 695. Ethyl Sulfocyanate. Prepared from ethyl iodide and silver sulfocyanate.

27 Miguel, P. B.A. 1877, i, 705. *Chem. Zentr.* 1876, 516. Silicon Sulfocyanate. Prepared from lead tetrathiocyanate and silicon tetrachloride. Insoluble in ether, benzene, and carbon disulfide. Decomposed by potash.

28 Parenti, C. B.A. 1891, 29. *Gazz. chim. ital.* 20, 178-83. Ethylene Di-thiocyanate. Prepared from perthiocyanic acid and ethylene bromide. Complex compounds formed.

29 Polacci, E. C.A. 1908, 1855. *Chem. Zentr.* 79 (1) 1576; *Arch. farmacol. sper.* 7, 94-6. The Detection of Thiocyanic Acid by Means of Mercurous Chloride. HCNS in saliva warmed with abs. $EtOH$, solution filtered and evaporated to half volume. The reduction of Hg_2Cl_2 to Hg shows presence of HCNS.

30 Proskauer, B., and Sell, E. B.A. 1877, i, 67. *Ber.* 9, 1262-6. Action of Bromine on Phenyl Sulfocyanate. Bromine and sulfocyanate in chloroform gave phenyl isocyanide and a complex substance which decomposed in water.

31 Schiff, R. B.A. 1877, i, 313. *Gazz. chim. ital.* 6, 244-55. A Series of Compounds Derived from Aldehyde-ammonia.
Heated aryl thiocyanate with aldehyde-ammonia. Studied product formed.

32 Sestini, F., and Funaro, A. B.A. 1882, 1180. *Gazz. chim. ital.* 12, 184-90. Action of Hydrogen on Thiocyanic Acid and Decomposition of the Thiocyanates in the Residues from Gas Manufacture.*

33 Stephani, O. B.A. 1902, i, 148. *Ber.* 34, 4283-91. Pseudophenols.
Prepared 3, 5-dibromo 2-hydroxybenzyl thiocyanate.

34 Tcherniac, J., and Hellon, R. B.A. 1883, 654. *Compt. rend.* 96, 587-9. *Ber.* 16, 348-59. Thiocyanacetone.

SCN · CH₂ · CO · Me is prepared from barium thiocyanate and monochloracetone. Can be distilled without decomposition.

35 Tcherniac, J. B.A. 1892, 1425. *Ber.* 25, 2607-20. Thiocyanacetone.
Discusses product formed on reaction between barium thiocyanate and chloracetone.

36 Tcherniac, J. B.A. 1892, 1426. *Ber.* 25, 2621-6. Preparation and Estimation of Thiocyanacetone.*

37 Tcherniac, J. B.A. 1893, i, 188. *Ber.* 25, 3648. Thiocyanacetone.
Reply to Hantzsch's criticism.

38 Thurnauer, G. B.A. 1890, 749. *Ber.* 23, 769-72. Preparation of Aromatic Thiocyanates.

39 Vollrath, A. B.A. 1872, 172. *Arch. Pharm.* [27] 148, 156. Allyl Sulfo-cyanate, a Constituent of Root of Mignonette.

Gives some experiments to show its presence but is not isolated.

40 Walden, P. C.A. 1908, 264. *Ber.* 40, 4301. Correction to the Note on the Preparation of Aliphatic Thiocyanates, Cyanides and Nitro Compounds.
The reaction of dimethyl sulfate on the above compounds was studied in 1901 by Kaufler and Pomeranz.

CROSS REFERENCES

Group 1—116; Group 2—80, 97; Group 3—34, 60, 88, 62; Group 4—12, 18; Group 5—28, 91; Group 10—8, 22, 38, 54, 96, 106, 110, 177, 188, 194, 198, 209, 274, 329, 374, 393; Group 11—9, 18; Group 12—1, 7, 18, 22, 24, 29, 56; Group 14—7, 33; Group 18—20, 136; Group 20—4; Group 21—17; Group 23—30; Group 24—6, 11, 13; Group 25—15, 43, 44, 45, 73.

GROUP 30

ISOTHIOCYANATES

1 Busch, M., and Reinhardt, J. C.A. 1910, 593. *Ber.* 42, 4602-10. Addition of Isothiocyanates to Aryl Hydrazines Substituted in the Nucleus.
a-m-Tolylphenyl-, β-m-tolylphenyl-, α-m-tolyl o-tolyl-, α-m-tolyl p-tolyl-thiocarbazides; also β- modifications and certain halogen and nitro derivatives are given.

2 Carlier, E. W. C.A. 1909, 1758. *Biochem. J.* 4, 107-16. Allylisothiocyanate: Some Aspects of its Physiological Action.
Action similar to allyl sulfide, but more powerful. Paralyzes the respiratory and vaso-motor centers, produces muscular spasms, affects heart beat and lowers body temperature.

3 Fluckiger, F. A. B.A. 1871, 835. *Arch. Pharm.* 145, 214-20. Practical Observations Concerning Mustard Oil.
Mustard oils are soluble in sulfuric acid without color formation. On decomposing forms sulfuric acid and oxysulfide of carbon.

4 Johnson, T. B., and Guest, H. H. C.A. 1909, 1749. *Am. Chem. J.* 41, 337-44. A New Class of Isothiocyanates, Isothiocyan Ethers.
Formed by action of KSCN or primary alkyl halides of type ROCH₂X. Certain ethers are given.

5 Miolati, A. B.A. 1893, i, 405. *Gazz. chim. ital.* 23 (1) 90-5. Thiocyanacetamide and Isothiohydantoin.
Prepare thiocyanacetamide from chloracetamide and Ba, K, or NH₄ thiocyanate. Gives on standing in H₂SO₄ solution isothiohydantoin.

CROSS REFERENCES

Group 3—92; Group 5—34, 74, 85, 91; Group 10—110; Group 12—56; Group 19—23; Group 21—18; Group 29—6, 7, 16, 22.

GROUP 31

MISCELLANEOUS

1 **Andrianowsky, A. B.A. 1879, 620.** *Bull. soc. chim.* [2] 31, 199. Action of Aluminum Chloride on Acetic and Sulfuric Anhydrides.
At 50°-60° forms $\text{AlCl}_2\text{SO}_2\text{Cl}$ (?), which decomposes at higher temperature. See *Ber.* 12, 853; *B.A.* 1879, 915.

2 **Bartal, A. C.A. 1907, 1523.** *Chem. Ztg.* 31, 347. Stability of Sulfur and Selenium Compounds.
Selenium compounds resemble those of tellurium more than those of sulfur.

3 **Baumann, L., Thesmar, G., and Frossard, J. B.A. 1905, i, 260.** *Bull. soc. ind. Mulhouse* 74, 348-60. Formaldehyde Sodium Hydrogen Hyposulfite.*

4 **Berthelot. B.A. 1879, 771.** *Compt. rend.* 88, 890. Action of Organic Solvents on Sulfur and Metallic Sulfides.
Studied action of ether on sulfur and various sulfides of iron. Crystals of pure sulfur were first deposited; afterwards a compound containing carbon, hydrogen, and sulfur, as the result of the influence of atmospheric oxygen.

5 **Ciusa, R. B.A. 1904, i, 425.** *Gazz. chim. ital.* 34, 102-4. Action of Phosphorus Pentasulfide on Benzophenone-oxime.
Reaction rapid at 80°, in CS_2 smooth. Substance $\text{C}_{10}\text{H}_{10}\text{O}_3\text{S}$ formed which on reduction with zinc and HCl gives off H_2S .

6 **Davy, E. B.A. 1875, 142.** *Phil. Mag.* [4] 48, 247-51. Action of Ammonium Sulfide on Chloral Hydrate.
Complex unidentified substance produced.

7 **Divers, E., and Shimidzu, T. J. Chem. Soc. Trans. 1886, 533-90.** Mercury Sulfites and the Constitution of Sulfites.
See paper for discussion and evidence.

8 **Dunnington, F. P. B.A. 1872, 674.** *Chem. News* 26, 259. Composition of Deposit from Retorts in which Carbon Disulfide Had Been Made.
Crust 33 mm. thick divided into 3 layers (6, 10, and 17 mm.). Layer in contact with iron contained 28.2% S, next 30.4% S, top layer 38.1% S. The carbon of the iron was completely removed.

9 **Earp, A. G. B.A. 1893, ii, 445.** *Phil. Mag.* [5] 35, 458-62. Boiling Points and Melting Points of Sulfur Compounds.
Substitution of S in place of O increases b. p. except where SH is concerned where reverse holds. Very few exceptions. Same holds for m. p. but more exceptions, particularly in case of more complicated compounds.

10 **Herschmann, P. B.A. 1893, i, 547.** *Monatsh.* 14, 233-44. Action of Sulfuric Acid on the Pinacone of Methyl Ethyl Ketone.
Conditions for formation of pinacoline given.

11 **Hodgson, H. H., and Beard, H. G. C.A. 1928, 405.** *J. Chem. Soc.* 1927, 2423-8. Sulfur Derivatives of Substituted Benzaldehydes.*

12 **Ishikawa, S. C.A. 1928, 1343.** *Sci. Papers Inst. Phys. Chem. Research (Tokyo)* 7, 301-12. Action of Metallic Salts upon Thioamides and Their Derivatives. I, Action of Mercuric Chloride upon Thioamides and Their Derivatives in Ether Solution.
Form addition compounds.

13 **Johnson, T. B., and Guest, H. H. C.A. 1909, 2705.** *Am. Chem. J.* 42, 271-87. Pyrimidines. CLXIV, Sulfur Derivatives of 5-Hydroxyuracil: Preparation of 5-Benzylmercaptouracil and 5-Benzylmercaptoctosine.
Preparation and properties given.

14 **Kindler, K., and Finndorf, F. C.A. 1921, 3454.** *Ber.* 54B, 1079-80. Thioamides. I, Preparation of Thioamides with the Aid of Aluminum Sulfide.
 Al_2S_3 is allowed to react on acid amides in presence of hydrated salts in sealed tubes at a high temperature in such proportions that an excess of H_2S is formed.

15 **Korner, H. C.A. 1908, 2699.** *Ber.* 41, 1901-5. Derivatives of Dithiocarbaminoacetic Acid.
Potassium salt, ethyl and methyl esters prepared. Other acids prepared.

16 **Levi, T. G. C.A. 1929, 5170.** *Atti. accad. Lincei* 9, 790-6. A New Class of Organic Sulfur Compounds.*

17 **Marckwald, W. B.A. 1893, i, 26.** *Ber.* 25, 3098-3115. (Compare Dixon, *Trans. Chem. Soc.* 1892, 1012.) Stereoisomeric Thiosemicarbazides.
All the thiosemicarbazides investigated exist in 2 forms: α -form is less stable and melts at a lower temperature than the β -into which it is converted when heated to a moderately high temperature or treated with HCl. See abstract or original for details.

18 **Nicol, W. W. J. B.A. 1882, 611.** *Proc. Roy. Soc. Edinburgh* 11, 199-202. Action of Heat on Thioformanilide.
On heating thioformanilide to 180° it is decomposed into H_2S and a body of unknown formula. See also *Ber.* 15, 2112; *B.A.* 1882, 958 for the same reaction.

19 **Paterno, E., and Mazzucchelli, A. B.A. 1907, ii, 451.** *Atti. accad. Lincei* [5] 16, i, 465-76. Blue Color of Sulfur and of Certain of Its Compounds.

Authors discuss blue color: 1. of ultramarine; 2. of the blue modification of sulfur; 3. obtained by adding an alkali polysulfide to boiling alcohol or acetone. See abstract.

20 Rheinboldt, H., and Schneider, K. C. A. 1929, 1614. *J. prakt. Chem.* **120, 238-48. Molecular Compounds of Organic Iodides with Sulfur.** The freezing point diagrams are given for a number of organic iodides with sulfur.

21 Rothmund, V. B. A. 1906, i, 233. *Monatsh.* **26, 1545-58. Action of Acetone on Alkali Sulfites.***

22 Rudert, P. B. A. 1893, i, 323. *Ber.* **26, 565. Action of POCl and PSCl on Aromatic Amines.** Gives products formed by the action of PSCl on ortho- and para-toluidines.

23 Salkowski, E. B. A. 1876, i, 949. *Ber.* **9, 140. Behavior of Substances Containing Sulfur in the Animal Organism. Connection Between Chemical Constitution and Physiological Action.***

24 Schiff, H. B. A. 1889, 234. *Ann.* **248, 144-6. Aldehyde and Acetone Sulfites on Organic Bases.** Monamines, di- and tertiary amines unite with aldehyde sulfites to form crystalline compounds.

25 Schrauf, A. B. A. 1886, 406. *Ann. Phys. Chem.* [2] **27, 300-14. Dispersion Equivalent of Sulfur.***

26 Shukla, P. P. C. A. 1928, 68. *J. Indian Inst. Sci.* **10A, Pt. 3, 33-41. In-**

fluence of the Sulfur Atom on Optical Rotation.*

27 Smith, L. B. A. 1876, i, 537. *Compt. rend.* **81, 1055-6. A Crystallized Sulfhydrocarbon Found in the Interior of a Mass of Meteoric Iron.** M. p. 115° - 120° , giving off sulfur and an odor of sulfuretted hydrogen and leaving a black residue.

28 Stewart, A. W. *Proc. Chem. Soc.* 1905, 78. A Further Note on the Addition of Sodium Hydrogen Sulfite to Ketonic Compounds. Extension of previous work (*J. Chem. Soc. Trans.* 1905, 185).

29 Wiedemann, E. B. A. 1873, 620. *J. prakt. Chem.* [2] **6, 453-5. Indices of Refraction of Sulfuretted Substitution Derivatives of Carbonic Ethers.** Two classes, carrying CO and CS . Replacement of O by S increases the refractive index of the liquid.

30 Wolbling, H. C. A. 1908, 1792. *Z. anorg. Chem.* **57, 281-9. On the Chemistry of Sulfur Nitride.** Addition compounds were made with TiCl_4 , SbCl_5 , and SnCl_4 in CCl_4 solution. Addition compounds could not be formed with SnCl_2 , SbCl_3 , AsCl_3 , PCl_5 , nor organic halogen compounds. The compound NSh is described.

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Group 2—31; Group 5—102; Group 6—8, 23; Group 10—68, 204, 381; Group 12—59; Group 19—1, 20; Group 25—109.

GROUP 32

THIOUREAS

1 Arzruni, A. B. A. 1871, 570. *Ber.* **4, 406. Contribution to the History of the Sulfur Ureas.***

2 Billeter, O. B. A. 1893, i, 575. *Ber.* **26, 1681-8. Penta-substituted Dithiobiurets.***

3 Braun, J., and Beschke, E. C. A. 1907, 723. *Ber.* **39, 4369-78. Preparation of Aromatic Thiocarbamides by the Hydrogen Peroxide Method.** Formed by action of CS_2 and H_2O_2 on an amine. The reaction was extended to various amines and the mechanism of the reaction discussed.

4 Bulmann, E. C. A. 1908, 1269. *Chem. Zentr.* 1907 (2), 1778-80. The Constitution of Thioamides. Thioamides and thiourethanes are believed to be tautomeric, because the former react with alkyl halides to form iminothioethers and thiourethanes pass to thiolurethanes in the same way.

5 Claus, A. B. A. 1893, i, 341. *J. prakt. Chem.* [2] **47, 135-8. Constitution of Thiocarbamide and Phenylthiobiuret.** Discussion of chance error that a compound has an SH group because a thioether is formed from it with alkali and alkyl halide.

6 Dixon, A. E. *J. Chem. Soc. Trans.* 1893, 318-28. Desulfurization of the Substituted Thioureas. Monosubstituted thioureas are desulfurized, di- when aliphatic, tri- with great difficulty, and tetraphenyl not at all, with alkaline lead oxide.

7 Dixon, A. E. *J. Chem. Soc. Trans.* 1893, 815-21. Action Between Thiourea and Some Haloid Derivatives of Fatty Acids. Dichloracetic acid yields thiohydantoin. α -Bromopropionic acid yields methylthiohydantoin.

8 Dixon, A. E., and Hawthorne, J. C. A. 1907, 1552. *J. Chem. Soc.* 91, 122-46. The Action of Acid Chlorides on Thioureas.
Acyl derivatives were formed in some cases. Additive compounds in other cases.

9 Dyson, G. M., and Hunter, R. F. C. A. 1926, 2313. *J. Soc. Chem. Ind.* 45, 81-5T. The Use of Thiocarbonyl Chloride in the Synthesis of Organic Sulfur Compounds.
A number of thioureas were prepared.

10 Evans, P. B. A. 1893, i, 129. *J. prakt. Chem.* [2] 46, 352. Condensation of β -Diketones with Carbamide and Thiocarbamide.
Condensation of acetylacetone and thiocarbamide.

11 Forster, M. O., and Jackson, T. C. A. 1908, 1010. *J. Chem. Soc.* 91-2, 187-90. Studies in the Camphane Series. XXIV, Camphoryldithiocarbamic Acid and Camphoryldithiocarbimide.
Former was prepared from latter and piperidine. Other compounds described in C. A. 1908, 838, given.

12 Fosse, R. C. A. 1908, 659. *Compt. rend.* 145, 813-5. The Action of Urea, Thiourea, Urethane and Acid Amides on Xanthydrol.
Condensation products are formed. M. p. and constants given.

13 Friedmann, A., and Gattermann, L. B. A. 1893, i, 153. *Ber.* 25, 3525-8. Action of Thiocarbimides on Aromatic Hydrocarbons.
Studies condensation of phenylthiocarbimide and benzene or toluene, using $AlCl_3$ as catalyst. Gives directions. Forms thiocarbanilides of benzene and toluene.

14 Fromm, E. B. A. 1893, i, 575. *Ann.* 275, 20-49. Phenyldithiobiuret.*

15 Fromm, E., and Vetter, E. C. A. 1908, 271. *Ann.* 356, 178-96. On Disulfides with Neighboring Double Linkages. Action of Amines and Hydrazines on Thiourets, New Synthesis of Triazoles.
Aniline and phenylthiouret hydrochloride warmed yield thiocarbamimide. In alcohol solution with excess aniline, S separated and phenylguanidinophenylthiourea formed. Action with phenylhydrazine given. May be acylated.

16 Kay, P. B. A. 1894, i, 76. *Ber.* 26, 2848-52. Action of Acids and Acid Anhydrides on Thiocarbimides.*

17 Landau, S. B. A. 1893, i, 32. *Ber.* 25, 3011-8. Mesitylene.
Mesityl-, dimesityl-, and allylmesityl-thiocarbamide prepared and constants given.

18 Maly, R. B. A. 1874, 684. *Chem. Zentr.* 1873, 218. Derivatives of Sulfurea.
Studied action of monochloracetic acid on sulfurea.

19 Matsui, M., and Ashida, E. C. A. 1919, 1463. *J. Tokyo Chem. Soc.* 40, 147-56. Electrolytic Reaction of Organic Sulfur Compounds. I, Thiocamide Group.
Authors believe reactions can be explained only on assumption that thiocamide group has structure $RC(X: NH)SH$. Experimental results seem to confirm their hypothesis.

20 Mazzara, G. B. A. 1893, i, 411. *Gazz. chim. ital.* 23, i, 37-43. Unsymmetrical Dibenzylthiocarbamide.
Method of preparation given.

21 Miguel, P. B. A. 1876, ii, 73. *Bull. soc. chim.* [2] 25, 104-6. A New Method for Preparing Thioureas.
Dry ammonia is passed into a solution of acetylulfocyanate. Acetyl thiourea separates. Others prepared.

22 Rolla, L. C. A. 1908, 1963. *Gazz. chim. ital.* 38 (1) 327-49. On Aminophenylurea and Aminophenylthiourea.
A few derivatives of aminophenylthiourea are given.

23 Smith, W. J. B. A. 1893, ii, 584. *Pflüger's Archiv.* 53, 481-90. Physiological Action of the Two Isomeric Ethylic Thiocarbamates.
The one with sulfur combined as $-CS \cdot OEt$ is more toxic than the one with sulfur as $-CO \cdot SET$. Symptoms of the nature of paralysis followed by death.

24 Tust, E., and Gattermann, L. B. A. 1893, i, 154. *Ber.* 25, 3528-30. Action of Phenol Ethers on Thiocarbimides.
Condensation of thiocarbimides and anisole or phenetole or other aryl ethers, by use of $AlCl_3$. Directions given.

25 Vanino, L., and Schinner, A. C. A. 1914, 1590. *Ber.* 47, 699-703. Benzoperoxide as a Means for Displacing Sulfur.
5 g. $CS(NH_2)_2$ and 16 g. peroxide allowed to stand a short time at 35° in alcohol showed that 75.79% sulfur was removed. If solution is boiled for 3 hours 95.97% sulfur removed. Other products formed at low temperatures are $BzOH$ and NH_2CN . 30% H_2O_2 at 5° for 2 hours yields $CS(NH_2)_2 \cdot H_2O_2$.

CROSS REFERENCES

Group 2—37; Group 3—11, 44; Group 5—18, 25, 74, 75, 79; Group 10—178, 268, 331; Group 12—31.

GROUP 33

XANTHATES

1 **Biilmann, E. B.A. 1902, i, 583. Ber. 35, 2184-7.** Formation of Cuprous Xanthate.

Reaction between copper sulfate and potassium xanthate.

2 **Cross, C. F., and Bevan, E. J. B.A. 1901, i, 452. Ber. 34, 1513-20.** Cellulose Xanthates.

General review of experimental results which the authors intend publishing later in detail.

3 **Loebisch, W. F., and Looss, A. B.A. 1882, 164. Monatsh. 2, 372-81.** Glyceryl Xanthates.

Formed by heating sodium glycerate with excess CS_2 in closed vessel at 55°-60° for 24 hours.

4 **Mylius, E. B.A. 1873, 266. Ber. 5, 972-7.** Carbonic and Sulfocarbonic Ethers of Isobutyl Alcohol.

Preparation of isobutyl xanthates and some derivatives.

5 **Oddo, B., and del Rosso, G. C.A. 1909, 1004. Gazz. chim. ital. [1] 39, 11-23.** Allylxanthogenic Acid.

The K and Na salts of this acid are made by action below 0° of CS_2 on solutions of the bases in allyl alcohol. Free acid unstable. Many salts prepared, also three esters.

6 **Phipson, T. L. B.A. 1877, ii, 597. Chem. News, 35, 270.** Observations on Some Xanthates. Separation of Nickel and Cobalt.*

7 **Salomon, F. B.A. 1874, 362. J. prakt. Chem. [2] 7, 114-22.** The Mixed Ethers of Xanthic Acid. Compares reactions of methyl ethyl ethers. See abstract.

CROSS REFERENCES

Group 4—9, 16, 22, 23; Group 5—11, 30, 49, 76; Group 10—43, 44, 55, 62, 94, 109, 137, 242, 250; Group 14—155, Group 23—23, 29, 34, 48, 50, 63, 64.

GROUP 34

SULFUR COMPOUNDS FOUND IN OILS, COAL, ETC., AND REFERENCES ON TREATING OF PETROLEUM AND OTHER NATURALLY OCCURRING PRODUCTS

1 **Ahrens, F. B.A. 1906, i, 473. Chem. Zentr. 1906, i, 510-1.** New Constituent of Coal Tar.

In a fraction from the benzene receiver which boiled at 20°-30°, butylene and a compound which contained sulfur and resembled CS_2 but was not identical with it have been found.

2 **Allner, W. C.A. 1910, 2997. J. Gasbel. 53, 733-7.** News of the Dry Sulfur Purification (Sulfur Purification of Gas).

A detailed description is given.

3 **Anderson, G. C.A. 1914, 3231. J. Gasbel. 57, 547-52.** The Removal of Sulfur from Illuminating Gas.*

4 **Anon. C.A. 1911, 2170. J. Gas. Lighting 113, 906.** Removal of Sulfur Compounds from Gas by Reheating.

Purified gas is reheated at 1200° F. when sulfur compounds are broken down into easily removable H_2S . Superheater will remove approx. 70% of total organic sulfur in gas.

5 **Anon. C.A. 1922, 4055. Petroleum Times 8, 331-2.** Sulfur in Shale Oils.

Present methods of treating oils to remove sulfur compounds are listed and discussed.

6 **Anon. C.A. 1923, 1546. Petroleum Times 9, 211-2.** The Hypochlorite Method of Oil Refining.*

7 **Anon. C.A. 1923, 2640. Petroleum Times 9, 867.** Desulfurizing Mineral Oils.

The Collinson process is described.

8 **Anon. C.A. 1927, 484. J. usines gaz. 50, 407-8.** Sulfur in Oils for Carbureting Water Gas.

Sulfur balances are given for com. water gas operations using 6 oils of varying sulfur content.

9 **Anon. C.A. 1928, 3769. Natl. Petroleum News 20, No. 27, 37.** Doctor Test Now Required of Natural Gasoline line.

The revised specifications of the Natural Gasoline Association of America require a doctor test.

10 **Anon. C.A. 1929, 965. Refiner Natural Gasoline Mfr. 7, No. 8, 63-4.** Sweetwater Plant Operation Minimizes Sulfur Trouble.

The distillation system of Sweetwater Refining Corporation for operation with Crane and Winkler county crudes is described.

11 **Bahr, H. C.A. 1928, 1841.** *Gas u. Wasserfach*, 71, 169-73. The Simultaneous Removal of Ammonia and Sulfur Compounds from Coal Gas.
Various processes are reviewed and a new process described.

12 **Baldeschwieler, E. L., and Cassar, H. A. C.A. 1929, 5467.** *J. Am. Chem. Soc.* 51, 2969-78. New Petroleum Product; Octanesulfone.*

13 **Barkley, J. F. C.A. 1928, 4225.** *Bur. Mines, Tech. Paper No. 436*, 7 p. The Sulfur Problem in Burning Coal.
Furnace reactions in burning coal are discussed and the effect of S content on clinkering is indicated.

14 **Bedson, P. P. C.A. 1911, 1181.** *J. Gas Lighting* 112, 928. Sulfur Compounds in Gas.
A report of experiments to show whether the air in consumer's premises is rendered harmful to occupants during burning of coal gas, by presence of sulfur compounds in gas.

15 **Birch, S. F., and Norris, W. S. G. P. C.A. 1925, 2407.** *J. Chem. Soc.* 127, 898-907. Chemistry of Petroleum. I, Occurrence of Compounds of Sulfur in the Light Distillate from the Crude Oil of Maidan-i-Naftun (Persia).
See article.

16 **Birch, S. F., and Norris, W. S. G. P. C.A. 1929, 1742.** *Refiner Natural Gasoline Mfr.* 7, No. 7, 94, 96, 98. Refining Cracked Distillate by Means of Hypochlorite.
Conclusions from experiments on the action of hypochlorite solutions on petroleum solutions of pure sulfur compounds are given. Data given.

17 **Birch, S. F., and Norris, W. S. C.A. 1929, 4805.** *Trans. Fuel Conference, World Power Conference London, 1928 (1)*, 641-68. Chemical Reactions Involved in the Refining of Petroleum.
Washing with soda, Na_2S , Na_2CO_3 , plumbite, PbS refining, hypochlorite process, acid washing, cuprammonium sulfate, SO_2 , Frasch Process, anhyd. AlCl_3 , and ZnCl_2 , bauxite, SiO_2 gel, fuller's earth are discussed and use of each given.

18 **Birch, S. F., and Norris, W. S. C.A. 1929, 4809.** *Oil and Gas J.* 28, No. 8, 46, 162, 164, 166, 168. Treating of Light Oil Distillates.
The action of sulfuric acid in removing sulfur compounds from light oil distillates is described. The special refining uses of cuprammonium sulfate, SO_2 , CuO , AlCl_3 , bauxite, alumina gel, fuller's earth and floridin are stated.

19 **Bjerregaard, A. P. C.A. 1925, 889.** *Ind. Eng. Chem.* 17, 142-4. Distribution of Sulfur in the Fractions Derived from Crude Petroleum.
Results of sulfur determinations on a number of American and one Mexican crude oils as well as their distillation derivatives are tabulated.

20 **Borgstrom, P., and Reid, E. E. C.A. 1927, 2785.** *Oil and Gas J.* 26, No. 4, 352-3. Sulfur Compounds in Mineral Oils.
A review of the literature containing 58 references.

21 **Brewer, A. F. C.A. 1922, 3379.** *Power* 55, 50-1. Effects of Sulfur in Fuel Oil.
Detrimental effects of sulfur on boilers due to sulfuric acid. Precautions suggested for lessening these harmful effects.

22 **Bruckner, H. C.A. 1929, 3560.** *Gas u. Wasserfach* 72, 442-5. Technical Processes for Removing Sulfur Compounds from Gases.
A critical review of the most important methods for removing sulfur compounds from gas with extensive references to patents and literature.

23 **Brysch, O. P., and Byrne, J. F. C.A. 1928, 4769.** *Proc. Am. Gas Assoc.* 1927, 1463-71. Organic Sulfur Content of Coke-oven Gas from Coals of Widely Varying Sulfur Content.
Data on various coals are given.

24 **Buckner, H. C.A. 1929, 261.** *Braunkohle* 27, 891-3. The Behavior of the Sulfur in Brown Coal on Dry Distillation.
Generally more than half of the total sulfur was lost on carbonization, presumably as H_2S . Pyrite sulfur suffered the heaviest loss apparently being converted into org. sulfur in the coke. The sulfates believed to be converted into sulfides, which in turn were converted into H_2S by action of CO_2 , etc.

25 **Burkheimer, W. C.A. 1927, 4049.** *Gas u. Wasserfach* 70, 943-5. The Recovery of Ammonia and Sulfur from Coal Gas by the Burkheimer Process.*
Extensive sampling has made possible the delineation of 2 areas of low sulfur coal in the southern part of that state.

26 **Cady, G. H. C.A. 1923, 1706.** *Illinois State Geol. Survey Bull. No. 33*, 433-4. Low Sulfur Coal in Illinois.
The preparation of coal is discussed, especially jigging.

27 **Campbell, J. R. C.A. 1920, 112.** *Bull. Amer. Inst. Mining Met. Eng.* 1919, 1779-89. Mechanical Separation of Sulfur Minerals from Coal.*
The preparation of coal is discussed, especially jigging.

28 **Campbell, J. R. C.A. 1920, 461.** *Bull. Am. Inst. Mining Met. Eng.* 1919, 3121-3. Mechanical Separation of Sulfur Minerals from Coal.
The preparation of coal is discussed, especially jigging.

29 **Campbell, J. R. C.A. 1920, 819.** *Mining and Met.* 1920, No. 157, Sect. 12, 17-8. Mechanical Separation of Sulfur Minerals from Coal.
A discussion.

30 **Challenger, F. C.A. 1927, 646.** *Ind. Chemist* 2, 445-8. The Occurrence of Sulfur in Mineral Oils.
The following methods of removing sulfur compounds from mineral oils are discussed: SO_2 , bauxite and bauxite + "Floridida earth," silica gel, hydrogenation, hypochlorite.

31 Chatfield, J. C. C.A. 1923, 2047. *Natl. Petroleum News* 15, No. 11, 133. Sulfur Compounds Giving Positive Doctor Test Found to be Harmless. Sulfur compounds in gasoline which produce a positive doctor test have no action on metals and are not injurious to automotive equipment. The free sulfur added in the doctor treatment, if not removed in refining processes, may cause corrosion.

32 Chemische Fabrik Griesheim-Elektron. C.A. 1910, 2037. *J. Gasbel* 52, 137-9. Commercial o-Dichlorobenzene for the Removal of Sulfur from Gas Purification Mass. Remarkable solvent for S in gas. At ordinary temperature dissolves 3.5% S; at 100°, 50% S; at 110°, about 200% S; at 115°, over 300% S. By extraction at 100°, absorptive power of mass unimpaired.

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34 Cooney, H. C.A. 1929, 965. *Refiner Natural Gasoline Mfr.* (7) No. 9, 92, 96. Sulfur Compounds and Natural Gasoline. An abstract of the literature of the subject.

35 Cornet, M. C.A. 22, 4238. *Chimie et industrie, Special No. 281-2.* (Apr. 1928.) A Study of the Sulfuric Acid Reaction of Mineral Oils.*

36 Crabtree, F., and Powell, A. R. C.A. 1920, 612. *Bull. Am. Inst. Mining Met. Eng.* 1919, 2687-92. Sulfur in Producer Gas. An abstract of the literature of the subject.

37 Craven, J. B., and Dunkley, W. A. C.A. 1923, 2184. *Am. Gas. Assoc. Monthly* 5, 251-4. Sulfur Compounds Other Than Hydrogen Sulfide in Gas as a Factor Governing the Selection of Gas Oils.*

38 Craven, J. B., et al. C.A. 1925, 1489. *Proc. Am. Gas. Assoc.* 1923, 1191-3. Organic Sulfur in Gas from Typical Plants.*

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40 Cundall, K. N. C.A. 1927, 1699. *Chem. Met. Eng.* 34, 143-7. Recovery of Sulfur from Gas. The process and apparatus are described for recovery of sulfur from the foul liquors of the liquid (Na_2CO_3) purification process.

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A sulfur content of 0.04% in gasoline is harmless to the engine. 0.15% causes appreciable corrosion, and 0.46% very serious corrosion. 0.18% is probably a fair limit for permissible sulfur.

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44 Dunstan, A. E. C.A. 1929, 1742. *Oil and Gas. J.* 27, No. 30, 138-9. Desulfurizing Petroleum Products. An adaptation of the Claus Process has been used for the desulfurization of gases containing up to 14% sulfur. A discussion of refining methods given.

45 Dunstan, A. E., and Thole, F. B. C.A. 1929, 4054. *Oil and Gas J.* 28, No. 1, 190, 194-5. Hypochlorite Treatment of Oils. In treating oils with hypochlorite, the proper effect depends upon the right amount of free alkali. The optimum conditions are given.

46 Dunkley, W. A., and Barnes, C. E. C.A. 1920, 2255. *Gas Record* 17, 33-6, 43-6. Sulfur Removal from Gas.*

47 Egloff, G., and Morrell, J. C. C.A. 1923, 2046. *Chem. Met. Eng.* 28, 633-5. Distribution of Sulfur in Petroleum Products. The distribution of sulfur in the primary products was as follows: coke 2.01%, residuum 62.08%, pressure distillate, 23.05%, gas 12.90%.

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50 Farmer, C. F. C.A. 1909, 2217. *Progressive Age* 27, 501. Preparation of Purifying Material and the Purification of Gas. A condensed description whose scope is indicated by the title. Fe_2O_3 is used for S removal.

51 Feld, W. C.A. 1910, 104. *J. Gas Lighting* 107, 816. Simultaneous Extraction of Ammonia and Sulfuretted

Hydrogen with Simultaneous Oxidation of the Latter into Sulfuric Acid. The washings, extraction, oxidation, regeneration, etc., are described.

52 **Ferbers, C. A.** 1929, 688. *Gas u. Wasserfach* **71**, 1133-7. Liquid Purification (Removal of Sulfur from Gas). Procedure and costs of operation given.

53 **Fischer, F. C. A.** 1920, 1431. *Ges. Abhandl. Kenntnis Kohle* **3**, 98-101. Sulfur Content of and Yield of Low Temperature Tar from Arsa Coal.*

54 **Fischer, F., and Dilthey, C. A.** 1927, 642. *Brennstoff-Chem.* **7**, 300. Direct Recovery of Pure Sulfur from Sulfur Containing Gases with Solutions of Copper. Gas passed through 10% CuCl_2 in saturated NaCl solution.

55 **Fischer, F., and Pranschke, A. C. A.** 1929, 2810. *Brennstoff-Chem.* **9**, 361-3. Formation of Sulfur-rich Carbons by the Action of Sulfur Dioxide. Products obtained in the process may not be compounds in which the sulfur is in combination with carbon but it does not act as though it were physically absorbed.

56 **Foerster, F., and Geisler, W. C. A.** 1922, 2587. *Z. angew. Chem.* **35**, 193-8. The Behavior of Sulfur in Coal During Dry Distillation. A typical gas coal and several lignites were studied. Determinations were made of pyritic, sulfate, sulfide and org. sulfur in the coals and cokes formed from them.

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60 **Fresnaye, de la, and Suchy. C. A.** 1917, 3424. *Mat. grasses* **10**, 4796-7. Desulfurization of Hydrocarbons. Hydrocarbons desulfurized by treating with organic substances, particularly esters alone or together with phenolic compounds, and with metallic compounds.

61 **Furth, A., and Jaenicke, M. C. A.** 1925, 1486. *Z. angew. Chem.* **38**, 166-73. The Desulfurization and Hydrogenation of Brown-coal Tar Oils. By passing the vapor with H over finely divided Ni at 200°-300°, the removal of the S and objectionable odor and color was practically complete.

62 **Galocsy, Zs. C. A.** 1929, 1737. *Tuzselestech.* **1**, No. 2, 8-11. Separation of Sulfur and Ammonia from Coal Gas and Generator Gas. A review of German methods.

63 **Gavalovski, A. C. A.** 1910, 1359. *Oest. Chem. Ztg.* **28**, 33. Coals Containing Sulfur. When coal is burned it can react with bodies which easily combine with sulfur to form undesired products. Coal of light sulfur content should not be used.

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65 **Ginter, R. L. C. A.** 1927, 1543. *Oil and Gas J.* **25**, No. 31, 84. Corrosion Hastened by Galvanic Action of Hydrogen Sulfide on Tank Steel. May be prevented by special paint coatings, treating out the H_2S , removing the FeS sediment.

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67 **Gray, J. C. A.** 1923, 3085. *J. S. African Chem. Inst.* **5**, No. 2, 12-6. The Distribution of the Forms of Sulfur in Transvaal Coal. The complete data are tabulated. No relation was found between total sulfur and organic sulfur.

68 **Halloran, R. A. C. A.** 1928, 1465. *Oil and Gas J.* [26] No. 29, 36, 147. Method of Refining Cracked Naphtha. The treatment of cracked naphtha with sulfuric acid at low temperature is described.

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70 **Harding, E. P., and Dunike, W. H. C. A.** 1928, 1033. *Ind. Eng. Chem.* **20**, 164. Distribution of Sulfur in Shale Oil. See article.

71 **Harding, E. P. C. A.** 1929, 5565. *Ind. Eng. Chem.* **21**, 818. Distribution of Sulfur in Oil Shale, III. The per cent of sulfur in various oil shales given.

72 **Harnist, Ch. C. A.** 1926, 2242. *Chemie et industrie* **15**, 506-13. Liquid Purification of Coal Gas and Recovery of Sulfur.*

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75 **Jacobson, D. L. C. A.** 1929, 1743. *Oil and Gas J.* 27, No. 36, 151, 169-70. Remove Sulfur from Refinery Gas. The Seaboard process of liquid gas purification is briefly outlined and various installations described.

76 **Jaeger, A. C. A.** 1923, 2183. *Brennstoff-Chem.* 3, 356. Sulfur Extraction from Spent Gas-purifying Using Tetralin (and Low Temperature Tar Oils). Hydrocarbons from low temperature tar are quite satisfactory solvents. Best results obtained with fractions boiling between the same limits as tetralin, 200°-210°.

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79 **Kada, R. and Ogata, K. C. A.** 1929, 3559. *J. Fuel Soc. Japan* 8, 414-28. Fixation of Sulfur in Coal Briquets. Fixation of sulfur to prevent disagreeable fumes in the use of coal briquets for domestic fuel was studied.

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81 **Kauffman, H. L. C. A.** 1929, 2283. *Refiner Natural Gasoline Mfr.* 7, No. 8, 73-4. Tests Show Sulfur Content of Different Fractions. The sulfur content is given of gasoline, kerosene, gas, oil, and wax distillate fractions and bottoms of Lander, Wyo., crude oils having an original sulfur content of 3.16% and Fort Soldier, Wyo., crude oils having an original sulfur content of 0.23%.

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83 **Kissling, R. B. A.** 1905, ii, 863. *Chem. Ztg.* 29, 1086. Heating of Mineral Oils When Shaken with Concentrated Sulfuric Acid. See original. Abstract gives method.

84 **Klemgard, E. N. C. A.** 1927, 2788. *Refiner Natural Gasoline Mfr.* 6 (No. 5) 51-2. Treatment of Cracked Naphtha with Sulfuric Acid at Low Temperature. Cold treatment of California cracked naphtha below 20°F. produces a 49% yield of superior gasoline having an average gravity of 44.1 Bé, and 0.30% S.

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86 **Lissner, A. C. A.** 1924, 1188. *Naturprodukte* 1923, 113-25. Removal of Sulfur from Coking Coal.*

87 **Little, A. D. C. A.** 1909, 1680. *Progressive Age* 27, 300. Sulfur in Coal and Illuminating Gas. A discussion of the S content in coal and gas and its influence on coal consumption and supply. The amount of S compounds in coal and water gas and the purification of the latter from S is discussed.

88 **Little, A. D. C. A.** 1909, 2747. *Progressive Age* 27, 573. Influence of Sulfur in Gas on Air in Rooms. S gases formed by combustion of gas removed from air in room in 3 ways: change of air by ventilation, condensation along with water vapors on cold walls and windows, and through absorption by the alkaline constituents of walls and ceilings.

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90 **Lozano, E. H. C. A.** 1925, 2740. *Quim. e ind.* 2, 92. The Desulfurization of Oils. Good results were obtained with concentrated HNO_3 . Org. sulfur was converted into SO_2 ; asphalt and higher aromatic compounds were precipitated.

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92 **Mabery, C. F. B. A.** 1894, i, 266. *Am. Chem. J.* 16, 88-93. Examination of Canadian Sulfur Petroleum. Sp. gr. 0.86 at 20°, slight odor of H_2S , 0.98% S. When distilled under 250 mm. yielded 11% under 150°, 0.5% S, 24% 150°-300° of 0.64% S, 65% residue of 0.98% S. Small quantities of H_2S evolved during distillation. Washed 150°-300° fraction with H_2SO_4 and will report later on S compounds in this fraction.

93 **Mabery, C. F. B.A. 1896, i, 269-70.** *Am. Chem. J.* **17**, 713-48; **18**, 43-79. Composition of Ohio and Canadian Sulfur Petroleum.
Sulfur compounds tend to collect in the higher fractions.

94 **Marcusson, J. C.A. 1918, 2435.** *Mitt. Materialprüfungsamt Berlin-Lichterfelde West.* **1917**, 374-80. Sulfur and Oxygen Compounds of Mineral Oils.*

95 **Meuser, J. W. C.A. 1926, 979.** *Het Gas* **45**, 97-107. Sulfur in Coal and Coke.
A phase rule study of the C-S complex.

96 **Monkhouse, A. C., and Cobb, J. W. C.A. 1922, 2767.** *Gas World* **76**, 542-8. Liberation of Nitrogen and Sulfur from Coal and Coke.*

97 **Morell, J. C. C.A. 1925, 1047.** *Ind. Eng. Chem.* **17**, 101-2. Chemistry of "Sweetening" in the Petroleum Industry.
Polemical against Wendt and Diggs.

98 **Morell, J. C., and Egloff, G. C.A. 1927, 2788.** *Petroleum World (Los Angeles)* **12 (No. 3)** 54-5, 84-5. The Economic Aspects of Desulfurization in the Refining of California Cracked Motor Fuels.*

99 **Morell, J. C. C.A. 1927, 2788.** *Ind. Eng. Chem.* **19**, 794-801. Polymerization and Other Chemical Reactions in the Sulfuric Acid Refining of Cracked Distillates.*

100 **Mougey, H. C. C.A. 1928, 1032.** *Ind. Eng. Chem.* **20**, 18-21. Sulfur in Gasoline from the Automobile Standpoint.
When cars are equipped with a crank case ventilator and thermostatic control of the water jacket temp., the condensation of water in the crank case is eliminated, and the sulfur corrosion greatly reduced.

101 **Murphy, E. J. C.A. 1917, 701.** *J. Gas. Lighting* **136**, 396-7. Removal of Sulfur from Spent Oxide.
Sulfur removed from spent oxide by making use of its solution in water-gas tar distillate.

102 **Nicolls, J. H. H. C.A. 1929, 259.** *Can. Dept. Mines, Mines Branch No. 689*, 34-50. Nature of Sulfur in Canadian Coal and Coke.*

103 **Odell, W. W., and Dunkley, W. A. C.A. 1920, 612.** *Bull. Am. Inst. Mining Met. Eng.* **1919**, 2301-11. Removal of Sulfur from Illuminating Gas.
Authors describe the older methods and the current practice together with several proposed methods which have not proved entirely satisfactory.

104 **Odell, W. W., and Dunkley, W. A. C.A. 1920, 1749.** *Mining and Met.* **1920, No. 157**, 60-3. Removal of Sulfur from Illuminating Gas (Discussion).

105 **Olin, H. L., and Troeltzsch, J. R. C.A. 1926, 3554.** *Iowa Geol. Survey* **31**, 157-65. Ash and Sulfur in Iowa Coals.
Mean values for sulfur were: pyrite, 2.66%; sulfate, 0.29%; organic, 1.86%.

106 **Ormandy, W. R., and Craven, E. C. C.A. 1926, 2581.** *J. Inst. Petroleum Tech.* **12**, 68-76. Observations of the Action of Sulfuric Acid on Gasoline.*

107 **Padovani, C., and Schiavil, S. C.A. 1928, 3513.** *Atti. congresso naz. chim. pura applicata* **2**, 609-24. The Sulfur Content of Lignites.*

108 **Papst, H. M. C.A. 1911, 2322.** *Am. Gas Light J.* **94**, 407. Removal of Organic Sulfur from Gas.
The gas is reheated at 1200° F. in a special apparatus. 70% of total org. sulfur removed.

109 **Papst, H. M. C.A. 1913, 1599.** *Gas World* **58**, 210. Removal of Organic Sulfur from Gas.
By reheating gas in checker brick work system. 62% to 78% removed.

110 **Parr, S. W. C.A. 1919, 3307.** *Bull. Am. Inst. Met. Mining Eng.* **1919**, 1807-9. Sulfur in the Coking Process.*

111 **Parr, S. W. C.A. 1920, 619.** *Mining and Met.* **1920, No. 157**, Sect. 12, 64-8. Sulfur in the Coking Process.
A discussion.

112 **Perkin, F. M. C.A. 1917, 2041.** *Chem. Trade J.* **50**, 251-2. Sulfur in Petroleum Oils.
CuO, a mixture of CuO, PbO and Fe₃O₄, 98% H₂SO₄, CaC₂, and liquid SO₂ have been employed in removal of sulfur from petroleum. Author treats oils with gaseous ammonia.

113 **Prince, N. F. C.A. 1928, 4769.** *Proc. Am. Gas Assoc.* **1927**, 1441-52. Laboratory Results on the Removal of Organic Sulfur from Gas.
Various tables given. See abstract.

114 **Powell, A. R. C.A. 1921, 306.** *J. Ind. Eng. Chem.* **12**, 1077-81. The Desulfurizing Action of Hydrogen on Coke.
Action of H₂ on coke around 1000° shows marked reduction of sulfur content through its elimination as H₂S.

115 **Powell, A. R. C.A. 18, 161.** *Am. Gas. J.* **119**, 441-6. Organic Sulfur and Cyanogen Removal from Gas.
Various methods are discussed.

116 **Queret, Y. C.A. 1929, 5029.** *J. usines gaz.* **53**, 373-86. Study of the Desulfurizing of Ammonia Liquors.
A brief survey of previous work is followed by a description of experiments.

117 **Ramsburg, C. J. C.A. 1910, 2725.** *Progressive Age* **28**, 428. Sulfur Compounds in Illuminating Gas.
Paper gives history of the subject, describes regulations and prescribes tests for a number of cities and states. Author thinks undue prominence given to regulation of H₂S in com. illuminating gas.

118 Reavell, J. A. C.A. 1929, 5030. *Chem. Age (London)* **21**, 103. Elimination of Sulfur Compounds from Flue Gases.
Washing flue gases in a chamber which reduces their velocity to below that in the flues, with ample supply of water, will remove 90% to 95% of sulfur compounds.

119 Reid, G. W. C.A. 1925, 2559. *Oil and Gas J.* **24**, No. 3, 119, 130, 132-3. Modern Treating Methods in Refining. A discussion of acid and sweetening treatment.

120 Rowsey, G. L., and Whitehurst, J. F. C.A. 1928, 1464. *Oil and Gas J.* **26**, No. 32, 250-4. Lead Sulfide Treating in Refining.*
The results of many refining agents are given.

122 Sayers, R. R., Smith, N. A. C., and Fieldner, A. C. C.A. 1925, 2875. *Bur. Mines Bull.* No. **231**, 1-8. Investigation of Toxic Gases from Mexican and Other High-sulfur Petroleums and Products.
Outline of the scope of the work and findings.

123 Schreiber, F. C.A. 1923, 2183. *Brennstoff-Chem.* **3**, 355-6. Use of Tetralin in Sulfur Recovery from Active Charcoal Used for Gas Purification.*
See article.

124 Selvig, W. A., and Fieldner, A. C. C.A. 1928, 1227. *Fuel Science Practice* **7**, 83-9. Sulfur in Coal and Coke.

125 Semmler, F. W. B.A. 1893, i, 104. *Arch. Pharm.* **230**, 443-8. Essential Oil of Onion (Allium Cepa L.).
Oil of formula $C_6H_{12}S_2$ and what is formed by treatment with potassium and zinc dust are given. Not identified.

126 Shatwell, H. G. C.A. 1926, 1713. *J. Inst. Petroleum Tech.* **11**, 548-55. The Hydrogenation and Desulfurization of Norfolk Shale Oil.
Data are tabulated to show Engler distillation tests giving sp. gr. and sulfur content of fractions. Data obtained upon hydrogenation and cracking in an atm. of N_2 show refining losses, sp. gr. and sulfur content.

127 Sissingh, D. W. C.A. 1923, 2953. *Brennstoff-Chem.* **4**, 113-8. The Desulfurizing of Mexican Oil Distillates According to the Frasch Method.*
See article.

128 Sissingh, D. W. C.A. 1925, 167. *Brennstoff-Chem.* **5**, 234. Desulfurization of Mexican Oil Distillates by the "Doctor Treatment."
See article.

129 Sissingh, D. W. C.A. 1925, 1491. *Brennstoff-Chem.* **5**, 22-5. Distillation of Sulfur-containing Petroleums.

The distribution of sulfur in the fractions was determined in each case. Sulfur content increased with sp. gr. of fractions except when cracking took place.

130 Smith, N. A. C., and Stark, D. D. C.A. 1924, 2242. *Bur. Mines Repts. Investigations No. 2582*, 17 p. Distribution of Sulfur in Petroleum.
The sulfur derivatives in oil are similar to those in asphalt.

131 Smith, N. A. C., and Stark, D. D. C.A. 1925, 2875. *Bur. Mines Bull.* No. **231**, 17-36. Chemical and Physical Characteristics of Typical High Sulfur Crudes Marketed in the United States.
A number of typical analyses are given.

132 Speer, F. W., Jr. C.A. 1929, 3792. *Proc. 2nd Intern. Conf. Bituminous Coal* **2**, 37-64. Gas Purification in Relation to Coal Sulfur.*
Albertite-like Asphalt from Indian Territory, U. S. A. Contains 1.4% S.

133 Taff, J. A. B.A. 1899, ii, 756. *Am. J. Sci.* [4] **8**, 219-24. Albertite-like Asphalt from Indian Territory, U. S. A. Contains 1.4% S.

134 Thau, A. C.A. 1926, 1314. *Gas u. Wasserfach* **69**, 125-8. Desulfurization of Large Quantities of Gas.
A discussion of the (German) costs of various types of large-scale installations.

135 Theissen, R. C.A. 1920, 608. *Bull. Am. Inst. Mining Met. Eng.* **1919**, 2431-43. Occurrence and Origin of Finely Disseminated Sulfur Compounds in Coal.
FeS and organic sulfur were found to be present. The stages of sulfur metabolism.

136 Thiele, F. C. B.A. 1903, ii, 83. *Chem. Ztg.* **1902-26**, 896-7. Free Sulfur in Petroleum from Beaumont.
Sulfur was found deposited from the crude oil.

137 Todd, E. W. C.A. 1929, 2017. *Proc. and Trans. Nova Scotian Inst. Sci.* **17** (2) 12-3. Removal of Sulfur from Illuminating Gas by Activated Carbon.
Conditions are given for removal. The sulfur in the gas was reduced to about 1/8 or 1/7 of its original value.

138 Waeser, B. C.A. 1928, 4230. *Chem. Ztg.* **52**, 617-8, 638-40, 658-9. Desulfurizing Gases.
Importance of removing S from gases discussed. Various methods reviewed. Full references to German, French, British and American patents are given.

139 Wallace, W. B.A. 1880, 708. *Chem. News* **41**, 201. Condition in which Sulfur Exists in Coal.
Chiefly exists as organic compound.

140 Waterman, H. I., and Sissingh, D. W. C.A. 1923, 1133. *Chem. Weekblad.* **19**, 489-92. The Desulfurization of Crude Oil Distillates.
Mexican oil distillates are treated either with concentrated sulfuric acid and NaOH, or sodium plumbite and flowers of sulfur. Treatment with sulfuric acid and NaOH diminishes sulfur content 50% to 60%.

141 **Waterman, H. I., and Heimel, J. H.** *C. A.* 1924, 3710. *Chem. Weekblad* **21**, 374-5. Desulfurization of Petroleum Distillates with Hypochlorite. Results were satisfactory except for thiophene.

142 **Watermann, H. I., and Heimel, J. H.** *C. A.* 1925, 889. *J. Inst. Petroleum Tech.* **10**, 812-5. The Desulfurizing of Crude Oil Distillates by Means of Hypochlorite after the Method of Dunstan and Brooks. See article.

143 **Watermann, H. I., Perquin, J. N. J., Bogaers, W. J. M. and Goris, J. R. H.** *C. A.* 1925, 3158. *Chem. Weekblad* **22**, 378-80. The Desulfurization of Petroleum Distillates by Means of Silica Gel. 60% of sulfur in a Mexican crude oil was removed by commercial silica gel.

144 **Waters, C. E. C. A.** 1922, 3752. *J. Ind. Eng. Chem.* **14**, 725-7. Sulfur Compounds and Oxidation of Petroleum Oils. Mineral lubricating oils that contain sulfur in large percentage are more easily oxidized, either by heating or by exposure to sunlight in presence of air, than those containing little sulfur.

145 **Weindel, A. C. A.** 1927, 2551. *Gas Age-Record* **59**, 775-6, 778. Sulfur Balance in Coke-oven Operation. Translation and summary of several foreign articles.

146 **Weindel, A. C. A.** 1927, 3121. *Brennstoff-Chem.* **8**, 85-9. The Sulfur Balance in Coke-oven Operation. Data on distribution of sulfur in the coking process are reviewed.

147 **Wheeler, R. V., and Jolly, J. C. A.** 1924, 2235. *Colliery Guardian* **127**, 1120. Decomposition of Sulfur Compounds in Coal by Heat. An investigation was carried out to determine the distribution of sulfur in the products of destructive distillation of coals in relation to the temperature and rate of heating, and factors which influence the retention of sulfur in coke.

148 **Wibaut, J. P., and Stoffel, A. C. A.** 1919, 2586. *Rec. trav. chim.* **38**, 132-58. The Sulfur of Coal. The Inorganic and Organic Sulfur of Coal and its Transformation During the Manufacture of Coke. Experiences in the quantitative determination of the pyrite of coal. See abstract.

149 **Wibaut, J. P. C. A.** 1923, 1706. *Brennstoff-Chem.* **3**, 273-8. Sulfur Compounds of Coal, Their Behavior on Distillation and the Sulfur Compounds of Coke. The work of Wibaut and others on this subject is critically reviewed.

150 **Wibaut, J. P. C. A.** 1923, 2186. *Chem. Weekblad* **20**, 242-4. The Combination of Sulfur with Carbon and its Importance from the Point of View of the Sulfur Content of Coke.*

151 **Will, E., and Koster, L. C. A.** 1924, 2238. *Mitt. Versuchsanstalt Dortmunder Union* **1**, 94-9. Desulfurization of Coke-oven Gas by Means of Activated Charcoal.*

152 **Will, E. C. A.** 1924, 2239. *Mitt. Versuchsanstalt Dortmunder Union*, **1**, 99-107. Desulfurization of Coke-oven Gas By Means of Lime at Elevated Temperatures.*

153 **Wittlich, M. C. A.** 1927, 3734. *Acta Comment. Univ. Dorpatensis* **8**, AVIII, 6, 1-12. Sulfur in Estonian Oil Shale (Kukersite) and its Distillation Products. The various oil shale beds and the distillation products in the production of coke and tar were analyzed for their sulfur content.

154 **Wood, A. E., Greene, A. R., and Provine, R. W. C. A.** 1927, 1004. *Ind. Eng. Chem.* **18**, 823-6. Desulfurizing Effects of Sodium Hypochlorite on Naphtha Solutions of Organic Sulfur Compounds. The removal of sulfur by solutions of NaOCl depends upon the type and m. w. of the sulfur composition, the per cent of NaOH in the solution, the relative volume of solution used, the time allowed for reaction and intimacy of mixing. Elemental sulfur and thiophene not attacked by most reactive solutions used. The literature is reviewed and apparent discrepancies reconciled.

155 **Woodruff, E. G. C. A.** 1927, 1544. *Amer. Pet. Inst.* **8** (No. 6) 410-4. The Action of Sulfur on Steel Tanks Containing Crude Oil. The amount of sulfur and its distribution in many crudes of the U. S. is shown in a table compiled from records of the U. S. Bureau of Mines. It is pointed out where sulfur may be expected in new fields in the U. S. and Canada.

156 **Woodward, Gladys E. C. A.** 1929, 405. *Ind. Eng. Chem.* **21**, 693-5. Silica Gel as a Reagent for the Extraction of High-sulfur Oils from Crude Petroleum. Silica gel reduced the sulfur content of Inglewood (Cal.) crude petroleum from 2.30% to 1.90%.

157 **Young, H. W., and Peake, A. W. C. A.** 1923, 2638. *Chem. Met. Eng.* **27**, 972-6. Use of Bleaching Powder for Sweetening Gasoline.*

CROSS REFERENCES

Group 1—135, 140, 145, 150, 151, 152; **Group 2**—17, 21, 22, 50, 53, 85, 92, 107, 110; 111; 112; **Group 3**—3, 12, 27, 30, 36, 38, 47, 48, 51, 53, 54, 58, 59, 62, 67, 73, 75, 85, 87, 99; **Group 5**—4, 23, 29, 40, 41, 46, 48, 54, 57, 65, 68, 77, 109; **Group 6**—4, 6, 10; **Group 10**—37, 46, 80, 118, 271, 399, 400, 423, 424, 425; **Group 12**—63, 93; **Group 14**—135, 136, 137, 204, 216, 223; **Group 15**—11; **Group 18**—22, 75, 107, 108, 112, 147, 165, 167; **Group 19**—3, 24.

SECTION II—U. S. PATENTS

The scope of this section is the same as that of Section I, *viz.*, sulfur compounds which may occur in petroleum and their properties, uses, and methods of removal from petroleum products. In its preparation, all U. S. patents up to January 1, 1930 in the following classifications¹ were covered:

Class 196—Sub-classes 23 to 46 inclusive, 78, 79, 92, 93, 96, 142, 144, 148.

Class 252—Sub-classes 2, 2.5, 3.

Class 44—Sub-class 9.

Class 87—Sub-class 9.

Class 260—Sub-classes 2, 7, 16, 17, 18, 19, 20, 21, 22, 23, 24, 27, 44, 53, 98, 125, 126, 155, 158, 159.

Class 48—*Gas Making*, in which there are a large number of patents relating to the desulfurization of gas; Class 18—*Plastic Compounds*, which contains many patents relating to the vulcanization of rubber; and other classes dealing with such topics as sulfonation and desulfurization of aromatic hydrocarbons and manufacture or use of sulfur dyes, thiazoles, etc., have not been included, as being outside the scope of this work.

3,145, see 63,051.

3,867, see 99,728.

8,833, Mar. 23, 1852, J. Young.

Treats petroleum distillates with H_2SO_4 and alkali.

9,630, Mar. 29, 1853, L. Atwood.

Treats coal tar distillate with $NaOH$ and then with H_2SO_4 . The oil is then neutralized and redistilled. The distillate is treated with H_2SO_4 , neutralized, and redistilled.

10,055, Sept. 27, 1853, W. Brown.

Treats oil distillates with H_2SO_4 and $K_2Cr_2O_7$, and then neutralizes with $NaOH$.

11,203, June 27, 1854, A. Gesner (to The Asphalt Mining and Kerosene Gas Co.)

Treats light distillate with acid, preferably contg. MnO_2 .

11,204, June 27, 1854, A. Gesner (to The Asphalt Mining and Kerosene Gas Co.).

Treats kerosene distillate with acid and MnO_2 , agitates, settles, decants, and neutralizes with CaO .

11,205, June 27, 1854, A. Gesner (to The Asphalt Mining and Kerosene Gas Co.)

Treats light distillate with H_2SO_4 , HNO_3 , or HCl and MnO_2 , and neutralizes with CaO .

11,740, see 575,640.

12,612, Mar. 27, 1885, A. Gesner (to North American Kerosene Gas Light Co.).

Treats distillate from bituminous material with acid and freshly calcined lime and redistills.

15,211, see 1,385,515.

15,505, Aug. 12, 1856, L. Atwood and W. Atwood.

Treats distillate with acid, neutralizes, and then treats with $KMnO_4$ and redistills. The distillate is again treated with acid, neutralized and redistilled.

15,506, Aug. 12, 1856, L. Atwood and W. Atwood.

Treats distillate with H_2SO_4 and neutralizes with caustic.

15,642, Sept. 2, 1856, C. Cherry.

Covers apparatus for distilling mineral oil with caustic alkali soln.

16,439, see 1,547,682.

16,679, see 1,592,329.

22,621, Jan. 18, 1859, R. R. Brown.

Lubricating compound containing S.

22,727, Jan. 25, 1859, E. N. Horner.

Uses a mixture of cream of tartar, $NaCl$, and slackened lime in the prime condenser.

¹ The U. S. Patent Office has divided its patents into 312 classes, each of which is subdivided into sub-classes, of which there are approximately 33,000. A list of these classes and sub-classes entitled "Manual of Classification of Patents" is available through the Superintendent of Documents, Washington, D. C. The definitions of these classes are published at periodic intervals by the Patent Office in the classification bulletins. The classifications above are defined in Classification Bulletins 44, 48, and 52.

23,167, Mar. 8, 1859, J. Griffin.
Distils coal tar products over CaO.

24,952, Aug. 2, 1859, H. Pemberton.
Dilutes residuum from acid treatment with steam to separate H_2SO_4 from the organic materials.

29,243, July 24, 1860, C. Chitterling.
Lubricating compound of the following constituents; oxalic acid, epsom salts, lamp black, S, and black lead.

31,982, Apr. 9, 1861, J. J. Johnston.
Purifies petroleum oil by distillation with wood charcoal.

32,704, July 2, 1861, J. Merrill.
Covers a still for distilling oil with caustic alkali.

32,705, July 2, 1861, J. Merrill.
Treats hydrocarbons with spent acid.

32,885, July 23, 1861, S. M. Mott.
Treats lubricating oil in the presence of NaCl, KNO_3 , CaO, common bar soap, and steam.

36,419, Sept. 9, 1862, A. Meucci.
Treats petroleum distillates with hyponitric acid.

37,918, Mar. 17, 1863, A. Millochau.
Mixes residuum from H_2SO_4 treatment with 40% H_2O , agitates thoroughly to remove as much acid as possible. Settles and separates. Washes with 20% solution of lye to neutralize and remove any traces of the acid.

38,015, Mar. 24, 1863, S. N. Tyler.
Treats burning oil with fusel oil or equivalent alcohols.

38,641, May 19, 1863, A. Millochau (to himself and A. Berney).
Washes residuum oil with alkali to remove odor.

40,068, Sept. 22, 1863, R. N. Warfield.
Passes steam through $CaCl_2$, NH_4Cl , and stone lime before passing it into oil to be treated.

41,068, Jan. 5, 1864, W. Hilton.
Lubricating compound containing petroleum oil, white resin, and flowers of sulfur.

41,085, Jan. 5, 1864, A. Millochau.
Produces an oil or grease from petroleum or coal tar residuum by diluting with benzine, treating with acid, and neutralizing.

42,671, May 10, 1864, S. Lewis.
Uses ashes and charcoal to deodorize light petroleum distillates.

43,325, June 28, 1864, J. Merrill.
Treats hydrocarbon oils with Na_2SO_4 and caustic alkali.

43,760, Aug. 9, 1864, J. H. Connelly.
Uses desulfurizing agents such as NaCl and CaO—in combination with petroleum or its products in the form of a spray—in a steam boiler or other furnace.

44,481, Sept. 27, 1864, W. Archer.
Treats oil in a thin film with H_2SO_4 .

44,519, Oct. 4, 1864, W. P. Downer.
Mixes petroleum or other oils with acid in a hermetically closed tank.

45,007, Nov. 15, 1864, W. Adamson.
Treats oil with acid or alkali by mixing with a paddle wheel.

48,367, June 27, 1865, R. A. Chesebrough.
Uses a combination of bone-dust, pulverized oyster shells, and cotton cloth for purifying oil.

49,502, Aug. 22, 1865, R. A. Chesebrough.
Uses bone black to purify oil.

50,571, Oct. 24, 1865, H. Fleury.
Distils oil in vacuum and pumps the condensate directly through H_2SO_4 first and then through caustic solution.

51,557, Dec. 19, 1865, R. A. Chesebrough.
Uses peat charcoal to purify oil.

51,558, Dec. 19, 1865, R. A. Chesebrough.
Uses alumina, etc., to purify oil.

52,897, Feb. 27, 1866, H. T. Slemmer.
Treats naphtha distillate with hot alkali solution.

53,656, Apr. 3, 1866, R. Newall.
Treats petroleum, etc., with a solution of lye containing chloride of lime, soda ash, and common lime, or their equivalents.

54,192, Apr. 24, 1866, L. M. Mott.
Distils oil in the presence of common salt, unslaked lime, KNO_3 , and KOH.

54,267, Apr. 24, 1866, J. Fordred.
Treats crude oil with NaOH or KOH solution.

54,495, May 8, 1866, H. B. Brace and W. T. Swart.
Treats gasoline, etc., with K_2CO_3 , $Al_2(SO_4)_3$, NaCl, gum benzoin, gum camphor, and spirit of niter.

54,978, May 22, 1866, H. K. Taylor and D. M. Graham.
Treats petroleum oil with nascent HCl, Cl_2 , Fl_2 , or equivalent gases.

54,984, May 22, 1866, P. Weisenberger.
Washes with hot water (212°F.) to remove acid after acid wash.

55,426, June 5, 1866, C. L. Morehouse (to himself and J. B. Merriam).
Agitates oil with air while treating with H_2SO_4 .

57,727, Sept. 4, 1866, J. Jann.
Prepares burning oil by decanting, after allowing to stand, a mixture of benzine, sweet oil, and oil of vitriol.

58,905, Oct. 16, 1866, G. W. Spangle.
Renders gasoline "inexplosive" by the addition of sal soda and cream of tartar.

59,177, Oct. 30, 1866, R. E. Campbell.
Treats distillate with burnt clay, chalk, NaCl, or equivalent.

59,751, Nov. 20, 1866, H. K. Taylor and D. M. Graham.
Treats oil with air and HCl generated by NaCl and H_2SO_4 .

60,290, Dec. 4, 1866, H. S. Van Tine.
Treats petroleum oil with H_2SO_4 , $ZnSO_4$, $PbAc_2$, and $K_2Cr_2O_7$, or equivalents.

60,559, Dec. 18, 1866, W. B. Rogers.
Treats kerosene or gasoline with mixture of NaOH, alum, NaCl, CaO, and "manganese."

60,585, Dec. 18, 1866, H. L. Smith.
Uses charcoal in a special apparatus for purifying oil.

60,757, Jan. 1, 1867, O. Lugo.
Treats petroleum with chromic acid and hypochlorite of soda.

60,829, Jan. 1, 1867, J. F. Boynton.
Anti-friction compound by combining S with hydrocarbon oils, tars, or their equivalents.

61,125, Jan. 8, 1867, P. H. Vander Weyde. Filters oil through charcoal, etc.

63,051, Sept. 19, 1866; Re 3145, Oct. 6, 1868, F. Hout (to himself and J. Rogers). Centrifuges a mixture of oil and bone black to separate the constituents.

63,229, Mar. 26, 1867, H. C. Dewitt. Treats coal oil with alum, cut potatoes, "pure carbon oil," alcohol, gum camphor, oil of sassafras, KAC, and sal soda.

63,749, Apr. 9, 1867, T. Restieaux. Dissolves Hg in HNO_3 - HCl mixture thereof, and treats petroleum with the product.

63,789, Apr. 16, 1867, J. Ellis and E. C. Kattell. Distils oil with steam in the presence of packing, such as turnings or scraps.

65,136, May 28, 1867, D. Symonds (to himself, B. Woodward and M. S. Marshal). Covers apparatus for distilling oil in the presence of CaO .

65,137, May 28, 1867, D. Symonds (to himself, B. Woodward and M. S. Marshal). Distils mineral oil with CaO or $\text{Ca}(\text{OCl})_2$.

65,313, May 28, 1867, W. Van Wyck. Uses a composition consisting of animal matter (blood), chalk, and wood charcoal to purify oil.

65,999, June 25, 1867, A. M. Burke and S. Wright. Distils mineral oil with alkali and treats the distillate with acid.

66,364, July 2, 1867, W. R. Loomis, N. Wells, H. Hitchcock, and S. G. Stryker. Makes burning oil by mixing naphtha, alum, NaCl , KOH, camphor gum, and spirits of niter.

68,669, Sept. 10, 1867, F. Sylvester. Purifies oil by passing it through hot water and treating with bone black.

68,942, Sept. 17, 1867, E. L. Brady. Combines various substances: oil, H_2O , Na_2CO_3 , CaO , S, and spirits of ammonia.

74,698, Feb. 18, 1868, J. D. Kirkpatrick (to himself and B. A. Rose). Filters burning oil through separate layers of CaO , wood ashes, elm bark, charcoal, and sand.

74,756, Feb. 25, 1868, G. W. Flowers, J. C. Happerset, and D. W. Happerset. Distils a mixture of gasoline, NaCl , I, and CaO .

76,838, Apr. 14, 1868, G. O. Spence (to himself, A. R. Williams and J. S. Lathrop). Adds flowers of sulfur to destroy cohesion or tenacity of lubricating oil.

77,959, May 19, 1868, R. A. Chesebrough. Produces "filtrene" by filtering lubricating oil through bone black.

81,071, Nov. 11, 1867, F. L. de Gerbeth (to T. S. G. Kirkpatrick). Prepares paint oil from petroleum by treatment with oxidizing agents, ozonized air, and galvanic electricity.

81,093, Aug. 18, 1868, J. A. Kestler. Heats lubricating oil stock with sal soda solution.

83,417, Oct. 27, 1868, P. Spence. Covers the use of protosilicates and protocarbonates of Fe to desulfurize gas.

88,978, Apr. 13, 1869, C. C. Parsons. Distils petroleum under vacuum and passes the vapors through purifying material, such as charcoal containing metallic oxides, to desulfurize.

90,405, May 25, 1869, T. Stewart (to himself and W. C. Stiles). Covers an oil filter containing charcoal, sand, etc.

91,447, June 12, 1869, J. J. Johnston (to J. T. Tyler, A. R. Hurst, H. M. Myers, and D. M. Armor). Distils hydrocarbon oil by passing it in a thin sheet over layers of charcoal.

91,654, June 29, 1869, T. E. Merrick. Treats distillate with H_2SO_4 and alkali.

96,097, Oct. 26, 1869, A. Farrar. Agitates residuum with NaOH solution, settles, and decants. The treated oil is then distilled over CaO .

97,262, Nov. 23, 1869, C. S. Moore. Incorporates among other things S in lubricating oil.

99,728, Feb. 8, 1870; Re 3867, March 1, 1870; J. A. Tatro. Treats distillate with H_2SO_4 and adds CaO or calcium phosphate to neutralize.

100,876, Mar. 15, 1870, A. Farrar. Deodorizes petroleum residuum for the preparation of printers' ink by heating with Cl_2 or $\text{Ca}(\text{OCl})_2$.

101,284, Mar. 29, 1870, O. Loew (to J. M. Pendleton). Washes oil with cold water. This treatment may be followed by treatment with H_2SO_4 and neutralization.

101,325, Mar. 29, 1870, J. H. Smyser. Uses waste vulcanized rubber (because it contains sulfur) and white lead in lubricating compound.

105,038, July 5, 1870, T. H. Burridge. Covers apparatus for treating oils with gases and liquids.

106,233, Aug. 9, 1870, J. A. Tatro. Treats petroleum distillate first with H_2SO_4 and then with $\text{Ca}(\text{OCl})_2$.

106,915, Aug. 30, 1870, G. Chevrier. Uses NaCl or AlCl_3 to separate oil from H_2SO_4 sludge.

109,772, Nov. 29, 1870, W. M. Sloane. Refines oils by agitating with any deodorizing agent under pressure with steam.

110,054, Dec. 13, 1870, G. Lupton. Treats benzine with Fe_2O_3 and CaO followed after settling with BaCl_2 and Na_2CO_3 .

110,364, Dec. 20, 1870, C. Houlker. Agitates used lubricating oil with soda ash liquor.

110,690, Jan. 3, 1871, J. H. Smyser. Lubricating compound composed of vulcanized rubber, petroleum, etc. (see 101,325).

112,453, Mar. 7, 1871, E. Q. Henderson (to J. C. Burroughs and R. A. Springs). Prepares lubricating oil by mixing resin, flowers of sulfur, and other constituents.

113,782, Apr. 18, 1871, R. G. Loftus. Adds a solvent such as naphtha before treating with H_2SO_4 .

118,359, Aug. 22, 1871, R. Gaggin.
Deodorizes paraffin with pure, dry Cl_2 with or without air.

120,349, Oct. 24, 1871, H. W. C. Tweddle.
Introduces CO_2 into agitating tanks to prevent explosions.

120,631, Nov. 7, 1871, G. M. Denison.
Lubricating compound containing tallow, S, and soapstone.

127,446, June 4, 1872, J. Young.
Treats hydrocarbons with HCl .

129,014, July 16, 1872, A. Farrar.
Blows air or steam through oil at 150° - 175° F. to remove offensive odors.

131,137, Sept. 3, 1872, H. Ujhely and C. Beurle.
Evaporates volatile matter from ozocerite and digests the residuum with fuming H_2SO_4 . The liquid wax is then treated with bone black.

132,379, Oct. 22, 1872, J. Williams.
Lubricating compound containing S among other things.

133,425, Nov. 26, 1872, H. W. Faucett and T. McGowan.
Covers apparatus for treating distillation vapors with H_2SO_4 , SO_2 , or Cl_2 .

133,598, Dec. 3, 1872, E. Schalk.
Covers an agitator.

134,890, Jan. 14, 1873, H. R. Hutchinson.
Adds to lubricating compound pulverized S among other constituents.

138,237, Apr. 29, 1873, A. Farrar.
Treats coal oil with acid and then washes with water and dries by heating to 300° F.

138,629, May 6, 1873, R. Gaggin.
Deodorizes with milk of $\text{Ca}(\text{OCl})_2$ at a temperature not over 140° . Temperature control necessary.

139,009, May 20, 1873, J. J. Looney.
Treats heavy crude petroleum previous to distillation with a mixture of benzine and H_2SO_4 .

146,405, Jan. 13, 1874, E. Schalk.
Treats distilled petroleum with H_2SO_3 or NH_3 .

156,714, Nov. 10, 1874, J. Scott.
Lubricating compound containing flowers of sulfur among other ingredients.

156,719, Nov. 10, 1874, J. Williams.
Lubricating compound containing flowers of sulfur as well as other ingredients.

157,848, Dec. 15, 1874, A. G. Mandel.
Lubricating compound containing flowers of sulfur.

160,759, Mar. 16, 1875, L. S. Fales and P. Neff.
Recover oil from spent acid and purifies by washing with H_2O and alkali.

161,672, Apr. 6, 1875, H. Dubbs.
Prepares a mixture of CaO and sawdust for decolorizing petroleum and other oils.

164,117, June 8, 1875, J. Williams.
Lubricating compound containing S.

164,694, June 22, 1875, A. T. Schmidt.
Distils oils in the presence of sulfite or hyposulfite.

167,730, Sept. 14, 1875, B. F. Bartlett.
Lubricating compound containing S.

170,581, Nov. 30, 1875, J. F. Mendonsa.
Lubricating compound containing S.

174,738, Mar. 14, 1876, W. Peters.
Axle grease containing S.

174,921, Mar. 21, 1876, C. L. Morehouse.
Treats oil with steam, washes with caustic solution and filters through a hot filter.

176,423, Apr. 25, 1876, W. J. Burgess (to himself and E. Turner).
Describes treatment of naphtha with H_2SO_4 followed by neutralization.

178,061, May 30, 1876, W. P. Jenney.
Washes sludge oil with H_2O , then alkali; then blows with steam in the presence of caustic soda and oxides of lead or manganese to oxidize any sulfurous body which may be in the oil.

178,154, May 30, 1876, W. P. Jenney.
Prepares resins from the sludge obtained by treating petroleum with H_2SO_4 .

179,744, July 11, 1876, J. G. Upper.
Lubricating compound containing S.

183,401, Oct. 17, 1876, D. M. Lamb.
Treats oil with HCl generated by H_2SO_4 and NaCl .

184,492, Nov. 21, 1876, M. Andersson.
Axle grease containing S.

186,951, Feb. 6, 1877, C. M. Pielsticker.
Melts ozokerite and treats with H_2SO_4 , washes, and neutralizes with $\text{Ba}(\text{OH})_2$ or NaOH .

190,762, May 15, 1877, W. P. Jenney.
Oxidizes sludge oil with H_2SO_4 .

199,789, Jan. 29, 1878, R. J. Chard.
Lubricating compound containing S.

211,762, Jan. 28, 1879, T. Marrin.
Treats paraffin distillate with sludge acid, decants the oil, washes with H_2O , and neutralizes with alkali.

215,756, May 27, 1879, J. L. Kirk.
Passes distillation vapors through a filter, treats the vapors with H_2SO_4 or other bleaching agents in vapor form, and then condenses.

216,518, June 17, 1879, H. F. Howell.
Treats crude petroleum or the like with Cl_2 gas.

224,295, Feb. 10, 1880, D. M. Lamb.
Prepares waterproofing compound by dissolving paraffin in gasoline, C_6H_6 , or the like, and treating with gas evolved from a mixture of NaCl and H_2SO_4 .

225,635, Mar. 16, 1880, P. Nicolai.
Covers a combined still and treating apparatus.

228,392, June 1, 1880, T. J. F. Regan (to F. S. Benson).
Treats naphtha with caustic lime.

232,685, Sept. 28, 1880, E. Clark.
Uses vacuum in connection with steam to aid in removing odors.

236,995, Jan. 25, 1881, E. J. De Smedt.
Heats coal tar with an oxidizing agent such as KMnO_4 , etc., to prepare pitch.

237,484, Feb. 8, 1881, R. A. Chesebrough.
Filters vaseline through charcoal.

237,662, Feb. 8, 1881, E. J. De Smedt.
Heats heavy petroleum oil with an oxidizing agent such as KMnO_4 , etc., to produce pitch.

240,093, Apr. 12, 1881, M. Connelly.
Heats petroleum in an open vessel with CaO or the like.

240,094, Apr. 12, 1881, M. Connelly.
Heats petroleum to drive off the H_2O and then treats with anhydrous or unslaked lime.

240,923, May 3, 1881, G. H. Perkins (to Atlantic Refining Co.).
Covers an agitator.

240,937, May 3, 1881, W. G. Warden (to The Atlantic Refining Co.).
Covers an agitator.

242,171, May 31, 1881, V. R. von Ofenheim and R. P. von Haidinger.
Purifies liquid bituminous material or fats by passage through hydrates of alumina, magnesia, Mn, or Fe; silicates of alumina or iron; or equivalent absorbent earth materials.

250,009, Nov. 22, 1881, E. Smalley ($\frac{1}{2}$ to E. D. Merritt).
Lubricating compound containing S.

257,961, May 16, 1882, T. McGowan.
Desulfurizes petroleum oil by treatment with O_2 and an alkali at 300° F. or above.

275,565, Apr. 10, 1883, H. Brackenbusch.
Treats solutions of colophony in heavy hydrocarbons with HNO_3 followed by treatment with H_2SO_4 and Fe filings.

280,277, June 26, 1883, M. L. Woodbury.
Journal packing consisting of S, etc.

281,491, July 17, 1883, D. T. Gray.
Filters paraffin through bone black.

284,589, Sept. 11, 1883, A. Andre Fils.
Separates resinous material from distillation residuum by treating with H_2SO_4 , and centrifuging.

287,643, Oct. 30, 1883, G. Dimick.
Lubricating compound containing S.

289,788, Dec. 4, 1883, H. Ujhely.
Decolorizes and deodorizes heavy mineral oils by dissolving them in light oil, adding potassium ferrocyanide, boiling, filtering, and distilling off the solvent.

294,840, Mar. 11, 1884, B. F. Bartlett.
Lubricating compound containing S.

299,167, May 27, 1884, J. Roswell ($\frac{1}{2}$ to De Golyer and Bro.).
Treats mineral oil successively with H_2SO_4 , alkali, and a solution of KNO_3 and H_2SO_4 .

299,324, May 27, 1884, R. Baynes, and J. Fearnside, Jr.
Bleaches and purifies mineral oil by adding pulverized dry coke or charcoal impregnated with anhydrous $ZnCl_2$ and distilling.

299,611, June 3, 1884, L. A. Baker ($\frac{1}{2}$ to E. A. Gould).
Decolorizes petroleum oils by filtering through snow.

305,180, Sept. 16, 1884, H. Halvorson (to The Halvorson Process Co.).
Treats with H_2SO_4 , and then with alcohol.

305,181, Sept. 16, 1884, H. Halvorson (to The Halvorson Process Co.).
Treats oil in successive stages with amyl and ethyl alcohols.

305,953, Sept. 30, 1884, D. S. Neiman.
Covers a filter containing layers of charcoal, CaO, and woolen cloth.

306,733, Oct. 21, 1884, L. H. Friedburg ($\frac{1}{2}$ to The U. S. Cottonseed Cleaning Co.).
Extracts cottonseed oil with naphtha which has first been chlorinated.

306,734, Oct. 21, 1884, L. H. Friedburg ($\frac{1}{2}$ to The U. S. Cottonseed Cleaning Co.).
Deodorizes oil by subjecting it in the form of drops to dry steam.

306,735, Oct. 21, 1884, L. H. Friedburg ($\frac{1}{2}$ to The U. S. Cottonseed Cleaning Co.).
Sprays oils or fats in a cylinder against a current of compressed air to chill the oil and separate stearic acid, etc.

306,897, Oct. 21, 1884, R. M. Breinig.
Process of treating sludge by mixing it with a soap compound. To purify odor of recovered acid, ordinary CaO or other disinfectant is used.

312,605, Feb. 24, 1885, L. Blumenthal.
Treats kerosene with air and sulfuric ether.

315,597, Apr. 14, 1885, R. M. Breinig.
Sludge acid treated with soap.

317,490, May 12, 1885, H. W. Belknap (by mesne to himself and H. C. Bartlett and J. A. Hartshorn).
Compound containing S for lubricating surfaces.

318,662, May 26, 1885, E. W. R. Schröter.
Prepares "ichthylsulfur acid" by treating shale oil with H_2SO_4 .

318,698, May 26, 1885, R. C. Clark and M. H. Warren.
Covers a combination still and filter.

321,465, July 7, 1885, J. H. Tiemann.
Removes H_2SO_4 from petroleum distillates by treatment with anhydrous alkali or alkaline earth compound.

330,637, Nov. 17, 1885, J. H. Tiemann.
Mixes clay, sand, or the like, with oil while treating with acid.

335,443, Feb. 2, 1886, C. Fink.
Lubricating compound containing S.

335,962, Feb. 9, 1886, E. Schaal.
Converts petroleum into acids by heating with an oxidizing agent (chromates, chlorates, etc.) in alkaline solution and injecting air.

336,941, Mar. 2, 1886, J. W. Norton and F. H. Rouse (1/3 to J. C. Fuller).
Covers apparatus for injecting steam, hot air, and chemicals or chemical gases into oil being distilled.

339,546, Apr. 6, 1886, J. B. Grant and A. Mason.
Covers apparatus for heating mixtures of oil vapors and acid or alkali, and filtering the condensate through acid or alkali.

342,500, May 25, 1886, R. Dean.
Deodorizes oil vapors by passing them through solid absorbents.

357,227, Feb. 8, 1887, J. Plante.
Lubricating compound consisting of powdered S, peat, and oil.

359,357, Mar. 15, 1887, E. D. Kendall.
Treats petroleum distillate with acid.

366,885, July 19, 1887, E. Schaal.
Distils petroleum under agitation with a current of air in presence of free alkali.

370,950, Oct. 4, 1887, D. M. Kennedy.
Desulfurizes mineral oil by treating with a solution of $CuSO_4$, $NaOH$, $NaCl$.

372,672, Nov. 8, 1887, T. G. Hall (to The International Oil and Refining Co.).

Desulfurizes oil by subjecting a mixture of the vapors with steam at above 420° F. to the action of converting surfaces of granite or equivalent material.

378,113, Feb. 21, 1888, G. W. Scollay.

Refines cottonseed oil by agitating with solid absorbent and filtering.

378,246, Feb. 21, 1888, H. Frasch.

Desulfurizes mineral oil by distilling with PbO mixed, if desired, with other oxides such as CuO.

379,492, Mar. 13, 1888, W. H. Pitt (1/2 to G. H. VanVleck).

Passes petroleum vapors through a vessel packed with pieces of metal to desulfurize.

389,020, 389,021, Sept. 4, 1888, A. Sommer.

Prepares compounds of fats or fatty oil with chloride of sulfur as one of the constituents.

389,898, Sept. 25, 1888, R. M. Perrine.

Bleaches wax by agitation with hot vapor of $\text{Ca}(\text{OCl})_2$ mixed with steam.

391,875, Oct. 30, 1888, E. A. Baumann (to Farbenfabriken vorm. F. Bayer and Co.).

Oxidizes mercaptols to sulfonals.

400,633, Apr. 2, 1889, F. M. F. Cazin.

Deodorizes oil by passing it in finely divided state through 1. H_2O ; 2. alkaline solution; 3. solution of heavy metal salt; 4. H_2SO_4 solution; 5. alkjaline solution, with subsequent washing.

401,500, Apr. 16, 1889, F. Kruger (to A. Leonhardt and Co.).

Prepares disulfonate by oxidation of mercaptols (ethyl mercaptols of benzaldehyde).

401,501, Apr. 16, 1889, F. Kruger (to A. Leonhardt and Co.).

Prepares tetramethyldisulfonemethane.

407,182, July 16, 1889, J. A. Dubbs.

Desulfurizes mineral oil by heating with arsenic and its salts.

408,472, Aug. 6, 1889, J. K. Field.

Acidifies mineral oil with fuming H_2SO_4 , agitates with bleaching material, acidifies again with H_2SO_4 , and agitates again with bleaching material.

410,067, Aug. 27, 1889, H. Bower.

Mixes oil and treating agent by means of opposed jets with or without the use of a finely divided solid agent.

411,394, Sept. 17, 1889, W. H. Pitt (to The Apex Refining Co.).

Deodorizes oil vapors by passing them through finely divided solid absorbent.

413,187, Oct. 22, 1889, E. D. Kendall (to Western Oil Refining Co.).

Deodorizes petroleum distillates by treatment with sulfur chloride.

414,601, Nov. 5, 1889, L. Stevens.

Desulfurizes oil by passing the vapors with steam through molten asphalt.

415,876, Nov. 26, 1889, F. W. Minshall.

Distils oil with steam in the presence of O_2 to desulfurize.

416,318, Dec 3, 1889, H. Baum (to F. VonHeyden Nachfolger).

Use of S_2Cl_2 and salicylic acid to produce dithiosalicylic acid which has an antiseptic action.

419,347, Jan. 14, 1890, R. M. Perrine.

Treats crude oil with $\text{Ca}(\text{OCl})_2$ and then H_2SO_4 .

419,726, Jan. 21, 1890, A. Sommer.

Prepares sulfochlorinated fatty bodies.

421,904, Feb. 25, 1890, W. Bruening.

Bleaches wax by atomizing it and exposing the atomized material to light, air and moisture, or "any other known bleaching agent."

423,522, Mar. 18, 1890, J. Lewandowski. Lubricant containing S.

425,905, Apr. 15, 1890, C. Rave.

Treats crude oil with H_2SO_4 and works up the acid tar to produce bitumen.

431,386, July 1, 1890, T. McGowan.

Covers apparatus for distilling oil in the presence of chemicals.

432,525, July 22, 1890, H. Goldwater.

Purifies oil vapors by distillation in the presence of charcoal, etc.

439,745, Nov. 4, 1890, E. A. Edwards.

Produces desulfurized illuminating oil by introducing steam and air into the distillation vapors in a specially constructed still.

440,830, Nov. 18, 1890, A. L. Munson.

Treats coal tar by heating to 110° F. and adding a saturated solution of ZnCl_2 and oil of turpentine.

442,094, Dec. 9, 1890, E. A. Baumann (to Farbenfabriken vorm. F. Bayer and Co.).

Prepares diethylsulfone diethyl methane.

442,802, Dec. 16, 1890, J. Gardner and J. F. Harris.

Desulfurizes oil by treating the vapors with metallic oxide.

444,833, Jan. 20, 1891, B. N. Hawes.

Covers apparatus for desulfurizing oil vapors by contacting them with gravel.

448,480, Mar. 17, 1891, H. Frasch (to The Solar Refining Co.).

Procedure and apparatus for desulfurizing petroleum by distillation in presence of metallic oxides.

451,660, May 5, 1891, E. D. Kendall (to himself and The International Oil and Refining Co.).

Desulfurizes mineral oil by treatment with HgCl_2 solution followed by alkali sulfide solution and redistilling with alkali.

451,724, May 5, 1891, T. J. Gordon.

Treats petroleum distillates successively with litharge, MgSO_4 , acid, alkali and water.

452,578, May 19, 1891, C. C. Mengel, Sr. Heats distillation vapors with natural gas before condensation to desulfurize.

454,061, June 16, 1891, T. McGowan.

Provides layers of filtering material in a column still through which vapors are passed.

461,513, Oct. 20, 1891, A. Sommer.

Lubricants to which has been added fat or oil which has reacted with sulfur chloride.

470,911, Mar. 15, 1892, J. A. Dubbs (1/2 to S. M. Boyd). Desulfurizes Lima crude by forcing a gas rich in H_2 through the oil before distillation.

471,963, Mar. 29, 1892, T. Drake. Treats petroleum oil with gaseous Cl_2 .

480,311, Aug. 9, 1892, O. P. Amend and J. H. Macy. Contacts petroleum vapors with an oxidizing agent, preferably with caustic alkali, to desulfurize.

480,312, Aug. 9, 1892, O. P. Amend and J. H. Macy. Contacts oil vapors heated above the boiling point of S with caustic alkali and condenses the vapor to desulfurize.

486,196, Nov. 15, 1892, C. H. Ridsdale and A. Jones. A lubricant containing S.

486,406, Nov. 15, 1892, J. B. Huston (to himself, J. B. Parsons, E. P. Williams and S. B. Lamoreaux). Passes distillation vapors with superheated steam through a superheater and absorbs H_2S from the gases produced by means of H_2O .

487,119, Nov. 29, 1892, H. Frasch (to The Solar Refining Co.). Treats petroleum vapors with metallic oleate, colophonate, etc., to desulfurize.

487,216, Nov. 29, 1892, H. Frasch (to The Solar Refining Co.). Desulfurizes Lima, etc., oils by distillation in the presence of salts precipitable by H_2S such as manganates, chromates, borates, sulfates, carbonates, etc.

488,628, Dec. 27, 1892, H. A. Frasch (Grasselli Chemical Co.). Treats sludge acids with cool water to remove free acid and then with alkaline solution and heat to dissolve sulfonic acids.

490,144, Jan. 17, 1893, H. Frasch (to The Solar Refining Co.). Apparatus for distilling petroleum with metallic oxides to desulfurize the oil.

492,419, Feb. 28, 1893, T. McGowan. Covers a still lined with mineral wool saturated with Na_2PbO_2 , for distilling S-containing oil.

492,421, Feb. 28, 1893, T. McGowan. Covers apparatus for distilling oil in the presence of powdered solid purifying substance.

495,124, Apr. 11, 1893, A. Spiegel. Produces sulfo-compounds by treating mineral oils with H_2SO_4 .

495,343, Apr. 11, 1893, E. Jacobsen. Heats paraffin oil with S to prepare sulfonic acids.

498,588, May 30, 1893, C. Toppan. Treats oils with gases evolved from a mixture of $NaCl$, Zn , and H_2SO_4 .

500,252, June 27, 1893, H. Frasch (to The Solar Refining Co.). Covers a metallic oxide composition for desulfurizing petroleum.

501,988, July 25, 1893, J. F. Carmen. Desulfurizes petroleum by passing the vapors through molten Pb or the like.

503,028, Aug. 8, 1893, G. Archbold (to H. L. Terrell). Extracts hydrocarbons from bituminous rock with H_2SO_4 .

507,230, Oct. 24, 1893, R. H. Laird (to W. H. Laird). Passes distillation vapors through a filter of salt, sand, and chloride of lime.

507,441, Oct. 24, 1893, H. Koehler (to Standard Oil Co. of N. Y.). Passes distillation vapors through CaO , and subjects the condensate to the usual forms of treatment for further removal of S compounds.

508,479, Nov. 14, 1893, A. Kayser. Subjects distillation vapors to the action of anhydrous HNO_3 .

513,204, Jan. 23, 1894, E. W. R. Schroter (to Ichthyol-Gesellschaft, Cordes, Hermanni and Co.). Prepares sulfonic acids of sulfurized oils.

516,766, Mar. 20, 1894, F. Krafft and A. Roos. Uses sulfonic acids as catalysts in the manufacture of ethers.

518,989, May 1, 1894, H. A. Frasch (to Grasselli Chemical Co.). Sulfonation of aromatic hydrocarbons in petroleum and separation of the sulfonic acids from oils.

518,990, May 1, 1894, H. A. Frasch (to Grasselli Chemical Co.). Forms sulfonic acid from petroleum and H_2SO_4 .

518,992, May 1, 1894, H. A. Frasch (to Grasselli Chemical Co.). Manufacture of sulfonated petroleum hydrocarbons.

522,028, June 26, 1894, W. B. Price. Desulfurizes oil by treating the distillate with HNO_3 , HNO_2 , or N_2O_3 , and distilling the treated oil with H_2SO_4 .

523,716, July 31, 1894, A. Sommer. Desulfurizes petroleum vapors by passage at 130° C. or above through anhydrous $CuSO_4$.

525,784, Sept. 11, 1894, L. O. Helmers (to Ichthyol-Gesellschaft, Cordes, Hermanni and Co.). Purifies sulfurized mineral oils.

525,811, Sept. 11, 1894, H. A. Frasch. Desulfurizes petroleum or its distillates by treatment with a substance containing free Cl_2 or chlorine products, washing with H_2O , treating with H_2SO_4 , then with plumbite.

525,969, Sept. 11, 1894, A. Sommer. Desulfurizes mineral oils by digestion with dry $CuSO_4$.

534,295, Feb. 19, 1895, J. J. Suckert (to himself and E. N. Dickerson, Jr.). Desulfurizes mineral oil by heating in the presence of metals and their oxides.

537,121, Apr. 9, 1895, C. Lossen. Mixes mineral oil with cuprous oxide and heats.

542,756, July 16, 1895, M. Ekenberg (to The Aktiebolaget Separator). Covers an emulsifier.

542,849, July 16, 1895, H. Frasch (to The Solar Refining Co.).
Desulfurizes Lima, etc., crude by distillation in the presence of nitrous acid fumes.

543,619, July 30, 1895, H. Frasch (to The Solar Refining Co.).
Treats petroleum vapors with dry oxides or oxygen salts of metals precipitated by H_2S in acid solution.

547,294, Oct. 1, 1895, F. Salathe (to The Union Oil Co. of Calif.).
Prepares paint vehicle from petroleum distillate by treating a specific fraction with acid and alkali and then oxidizing the treated oil.

547,329, Oct. 1, 1895, F. X. Byerley.
Blows Lima crude oil with air during distillation, treats the distillate with acid, and neutralizes with alkali.

548,391, Oct. 22, 1895, W. B. Price.
Treats kerosene with strong H_2SO_4 at above 100° C.

549,728, Nov. 12, 1895, F. Krafft and A. Roos.
Prepares esters, as by heating benzenesulfonic ester with acetic acid to a temperature of 140°-150° C., to prepare ethyl acetate and benzenesulfonic acid.

551,941, Dec. 24, 1895, O. P. Amend and J. H. Macy.
Desulfurizes mineral oil by agitating and heating with alkali, adding a dehydrating agent such as Al_2O_3 or PbO , and separating the oil from the precipitate formed.

556,155, Mar. 10, 1896, W. P. Lowe and C. W. Bilfinger (to The Manhattan Oil Co.).
Covers a still for distilling mineral oil with steam to remove S compounds.

557,291, Mar. 31, 1896, A. J. Tempére.
Treats kerosene with amyl acetate.

558,747, Apr. 21, 1896, C. A. Smith (to The Ohio Oil Improvement Co.).
Desulfurizes petroleum by treating the distillate with an active element such as Pb and an inactive element such as C, followed by acid treatment.

559,783, May 5, 1896, A. Müller-Jacobs (to S. Sultan and W. F. Weiss).
Prepares artificial musk by treating kerosene with H_2SO_4 and HNO_3 , neutralizing with alkali, and precipitating the odoriferous substance with a metallic soap.

560,463, May 19, 1896, F. Berg (to J. B. Meriam).
Desulfurizes petroleum before distillation by treatment with H_2SO_4 and alkali at 110° F. or above.

561,216, June 2, 1896, H. Frasch (to The Solar Refining Co.).
Treats cracked distillate with H_2SO_4 and redistills in the presence of diffused CaO or the like.

564,341, July 21, 1896, F. Salathé (to The Union Oil Co.).
Prepares a vulcanized bituminous product by heating bitumen with S.

564,920, July 28, 1896, H. Frasch (to The Solar Refining Co.).
Apparatus for carrying out the process described in 564,921.

564,921, July 28, 1896, H. Frasch (to The Solar Refining Co.).
In desulfurizing petroleum vapors by contact with solid reagent, the vapors are divided and passed through a plurality of purifiers.

564,922, July 28, 1896, H. Frasch (to The Solar Refining Co.).
The purifying material for desulfurizing oil is swelled or expanded by treatment with air.

564,923, July 28, 1896, H. Frasch (to The Solar Refining Co.).
Burns desulfurizing material in situ by passing air through the apparatus.

564,924, July 28, 1896, H. Frasch (to The Solar Refining Co.).
Covers a process and apparatus for burning the spent desulfurizing material under the still.

565,039, Aug. 4, 1896, G. M. Saybolt (to Standard Oil Co. of N. J.).
Treats petroleum distillate with acid followed by solid alkali without washing.

565,040, Aug. 4, 1896, G. M. Saybolt (to Standard Oil Co. of N. J.).
Treats kerosene distillate with non-fuming H_2SO_4 , washes, and agitates with solid alkali.

572,676, Dec. 8, 1896, H. Frasch (to The Solar Refining Co.).
Distils oil in the presence of Cu matte to desulfurize.

575,640, Jan. 19, 1897; Re 11,740, May 9, 1899, P. Fritzsche.
Prepares ether by absorbing C_2H_4 in H_2SO_4 and treating the resulting products to produce the ether.

580,652, Apr. 13, 1897, M. Schiller.
Distils hydrocarbon oils containing S compounds in the presence of Zn dust and alkali.

583,779, June 1, 1897, J. R. Whiting and W. A. Lawrence.
Passes oil vapor through charcoal, then through lime water, and then condenses.

586,520, July 13, 1897, G. H. Moore (7/12 to D. McKenzie, C. E. French and J. Van Horn).
Desulfurizes Lima, etc., crude by distilling with $NaOH$, $Ca(OH)_2$, Na_2SO_4 , and treating the distillate with H_2SO_4 and alkali.

595,788, Dec. 21, 1897, H. J. Small and H. Stillman.
Covers apparatus for treating C_6H_6 with H_2SO_4 .

596,410, Dec. 28, 1897, O. Lugo (to The Orlu Manufacturing Co.).
Heats oil with sodium aluminate solution.

596,437, Dec. 28, 1897, W. A. Smith.
Adds turpentine or resin and heats before the ordinary acid and alkali treatment.

597,920, Jan. 25, 1898, E. A. Starke.
Treats kerosene with acid, neutralizes in the usual way, and then treats with SO_3 , preferably dissolved in H_2SO_4 , H_3PO_4 , or the like.

601,331, Mar. 29, 1898, O. P. Amend (1/2 to J. H. Macy).
Desulfurizes petroleum oils by treatment first with fuming H_2SO_4 followed by treatment with ordinary H_2SO_4 .

602,942, Apr. 26, 1898, L. O. Helmers (to Ichthyol Gesellschaft, Cordes, Hermanni and Co.).
Forms an iodine-soluble derivative of ichthyol.

604,280, May 17, 1898, H. Wolf (to Badische Anilin and Soda Fabrik).

Treats oil by injecting fuming H_2SO_4 between concentric streams of the oil moving at different velocities.

604,515, May 24, 1898, J. Bragg.

Treats petroleum oil with a metallic soap (Mn or Pb oleate or colophonate) followed by acid, alkali, H_2O , and steam treatments.

607,017, July 12, 1898, T. F. Colin.

Distils Lima or like crude oil with a peroxide such as Na_2O_2 , BaO_2 , PbO_2 , or with corresponding salts, to desulfurize.

611,620, Oct. 4, 1898, C. B. Forward and J. M. Davidson (to The Forward Reduction Co.).

Makes asphalt from petroleum by treating with acid, adding heavy oil and heating.

618,307, Jan. 24, 1899, A. Wendtland.

Decolorizes acid-treated petroleum residues by treating with soap solution, $BaCl_2$ solution, and finally filtering through bone black impregnated with alcohol.

620,882, Mar. 14, 1899, A. J. Boote and H. G. W. Kittredge (1/3 to F. H. Steel).

Desulfurizes oil by treating with plumbite solution followed by $Ca(OCl)_2$.

622,799, Apr. 11, 1899, H. Frasch (to The Solar Refining Co.).

Desulfurizes petroleum by passing the vapors through a chamber packed with small pieces of metal.

623,066, Apr. 11, 1899, F. Berg.

Heats crude oil with alkali, settles, distils, treats the distillate with acid, neutralizes with alkali, redistils, and treats the re-run distillate with acid.

624,027, **624,028**, May 2, 1899, L. O. Helmers (to Ichthyol Gesellschaft, Cordes, Hermanni and Co.).

Heats sulfonic acid salts of alkaline earth metals and "metals proper" derived from sulfureted hydrocarbons combined with H_2SO_4 , to render them tasteless.

625,332, May 23, 1899, L. O. Helmers (to Ichthyol Gesellschaft, Cordes, Hermanni and Co.).

Oxidizes cold and then concentrates by heating sulfonized compounds derived from sulfureted mineral oils by treatment with H_2SO_4 (ichthyol).

625,480, May 23, 1899, H. Vieth (to Knoll and Co.).

Deodorizes ichthyol compounds by steam distillation.

628,503, July 11, 1899, E. Twitchell.

Prepares a sulfo-fatty aromatic compound by mixing a fatty acid with an aromatic compound and sulfonating with H_2SO_4 .

630,496, Aug. 8, 1899, H. Frasch (to The Solar Refining Co.).

In desulfurizing petroleum by passing it preferably as vapors, through small pieces of metal, acid is passed over the metal to revivify it.

632,363, Sept. 5, 1899, J. H. Peacock. Lubricant of glycerine and S.

640,918, Jan. 9, 1900, A. Kayser.

Desulfurizes mineral oil by mixing CO with the vapors and heating the mixture in a coil.

649,047, May 8, 1900, H. Frasch (to The Solar Refining Co.).

Dissolves in the oil to be desulfurized a fatty or resinous acid before treatment with metallic oxides.

649,048, May 8, 1900, H. Frasch (to The Solar Refining Co.).

Heats Lima or like petroleum oil in the liquid state with metal oxides.

651,474, June 12, 1900, G. A. Abbott.

Prepares a filtering material consisting of clay and lignite.

655,500, Aug. 7, 1900, T. Macalpine (to The Alcohol Syndicate, Ltd.).

Treats petroleum oil with a compound of C_6H_2 and Mn.

658,857, Oct. 2, 1900, T. McGowan.

Desulfurizes Lima crude by distillation with H_2SO_4 .

664,017, Dec. 18, 1900, A. M. Edwards.

Makes coke by mixing crude oil with diatomaceous earth and distilling off the lighter fractions.

664,408, Dec. 25, 1900, J. C. Henderson (to The Maize Products Co.).

Covers a filtering composition consisting of alternate layers of fuller's earth and sand.

664,677, Dec. 25, 1900, R. E. Pippig and O. F. F. Trachmann.

Desulfurizes illuminating gas by scrubbing with an alcoholic solution of aniline.

665,925, Jan. 15, 1901, H. Nordtmeyer.

Prepares filtering material from kieselguhr and asbestos.

666,446, Jan. 22, 1901, J. W. Warren (1/2 to I. H. Warren).

Clarifies sulfurous hydrocarbon oils by agitating with Wyoming rock clay, settling, and decanting.

671,078, Apr. 2, 1901, J. T. Davis.

Distils crude petroleum in the presence of an oxidizing agent such as $K_2Cr_2O_7$.

671,135, Apr. 2, 1901, L. O. Helmers (to Ichthyol Gesellschaft, Cordes, Hermanni and Co.).

Prepares sulfonic acids and their salts.

680,290, Aug. 13, 1901, M. Thomas.

Mixes 99% sawdust and 1% NaCl to prepare a filtering material.

681,568, Aug. 27, 1901, A. C. McLaughlin. Manufactures ichthyol sulfonate of ammonium.

683,354, Sept. 24, 1901, F. C. Thiele (3/5 to J. Finke and J. M. Parker).

Treats Lima crude oil with HNO_3 followed by addition of metallic powder to produce nascent H.

685,895, Nov. 5, 1901, E. Wirth.

Separates carbazole and its homologs from crude anthracene by treating with a solvent and HNO_2 .

685,907, Nov. 5, 1901, T. F. Colin.

Desulfurizes Lima, etc., petroleum by simultaneous treatment with a dry metal or metal oxide which has a strong affinity for O_2 , and H_2SO_4 .

686,248, Nov. 12, 1901, C. C. Barnes.

Prepares decolorizing and purifying compound.

686,663, Nov. 12, 1901, T. Macalpine (to Alcohol Syndicate, Ltd.).
Prepares a Mn compound for treating petroleum oils by subjecting a solution or emulsion of the alkalies or alkaline earths to the action of C_2H_2 and adding the product to a solution containing Mn.

692,283, Feb. 4, 1902, J. N. Harris (to The Globe Trading Co., Ltd.).
Heats oil to $110^{\circ}\text{--}130^{\circ}\text{ F.}$ with powdered decolorizing material and aerates in the presence of alcohol.

700,373, May 20, 1902, J. S. Roake (to W. K. Hale and C. W. Kürsteiner).
Covers apparatus for introducing alkali during distillation of wood, etc.

705,168, July 22, 1902, J. W. Warren.
Treats hydrocarbon oils successively with $PbAc_2$, H_2SO_4 , and powdered Wyoming rock clay.

709,321, Sept. 16, 1902, L. O. Helmers (to Ichthyol Gesellschaft, Cordes, Hermanni and Co.).
Separates sulfonic acids by formation of salts with aniline or other organic bases.

713,475, Nov. 11, 1902, J. C. Mims (½ to G. Kohnke).
Removes asphaltum from mineral oil by treating with $K_2Cr_2O_7$ and H_2SO_4 , followed by treatment with $NaOH$.

716,132, Dec. 16, 1902, J. S. Stewart-Wallace and W. B. Cowell.
Heats mineral oil with $NaOH$ and $KMnO_4$, settles, separates the oil, and distils.

721,426, Feb. 24, 1903, F. E. Collins.
Filters oil through charcoal, etc.

722,506, Mar. 10, 1903, L. O. Helmers (to Ichthyol Gesellschaft, Cordes, Hermanni and Co.).
Manufactures soluble alkali earth and metallic sulfonates.

722,507, March 10, 1903, L. O. Helmers (to Ichthyol Gesellschaft, Cordes, Hermanni and Co.).
Prepares oxidized sulfonic-acid salts.

723,368, Mar. 24, 1903, T. F. Colin and O. P. Amend.
Desulfurizes petroleum and its distillates by oxidation of the S without precipitation by means of a hypochlorite in alkaline solution in the presence of an O_2 carrier or catalytic agent.

732,937, July 7, 1903, C. B. Graham.
Purifies oil by passing it through a solution of lime water, pyrogallic acid and KOH .

736,479, Aug. 18, 1903, F. Berg.
Refluxes oil with an alkali.

738,656, Sept. 8, 1903, A. W. Burwell and L. O. Sherman.
Desulfurizes petroleum by passing the vapors in contact with an anhydrous mixture of oxides of iron and an alkaline earth metal.

741,517, Oct. 13, 1903, T. Macalpine (to Alcohol Co., Ltd.).
Treats oil with saline solution, then with an oxidizing reagent, and distils in presence of a manganese compound.

744,720, Nov. 24, 1903, T. F. Colin.
Desulfurizes petroleum and its distillates by treatment with an aqueous solution of an Fe salt, $NaCl$, and a Cu salt, and agitating with air.

747,348, Dec. 22, 1903, O. P. Amend (½ to J. H. Macy).
Desulfurizes oil by treatment with alkaline Cu solution.

747,348, Dec. 22, 1903, O. P. Amend (½ to J. H. Macy).
Desulfurizes oil by treatment first with a soluble salt of Cu and then with a soluble carbonate.

749,078, Jan. 5, 1904, O. Meyer.
Prepares ethyl sulfuric acid for the formation of ether by fermenting carbohydrate material, distilling the mash, and bringing the vapors directly into contact with H_2SO_4 .

752,744, Feb. 23, 1904, N. Zelinsky.
Produces organic acids from petroleum by chlorination and then treating the chlorinated products with Mg and H_2CO_3 successively.

761,939, June 7, 1904, F. Boleg (to Gesellschaft zur Verwertung der Boleg'schen Wasserlöslichen Mineralöle und Kohlenwasserstoffe G.m.b.H.).
Prepares aqueous solutions of mineral oil by treating a mixture of mineral oil and resin oil with steam, boiling the mixture and adding lye, separating the sludge, and treating the oil with distilled H_2O and compressed air.

764,099, July 5, 1904, O. P. Amend.
Desulfurizes mineral oil by treatment with Cu hydrate and then subjects the resulting CuS to action of one or more oxidizing agents, as $FeSO_4$ and air or steam.

769,681, Sept. 6, 1904, A. C. Calkins (½ to H. E. Brett).
Treats oil with H_2SO_4 in a closed vessel and recirculates evolved vapors through the oil.

770,214, Sept. 13, 1904, H. S. Blackmore.
Produces "hydrogen carbide" by heating sulferous petroleum or so-called Lima oil with metallic carbides.

772,129, Oct. 11, 1904, W. M. Burton (to Standard Oil Co. of Indiana).
Sulfonates oleic acid as a step in the manufacture of hydroxystearic acid from oleic acid.

783,916, Feb. 28, 1905, G. von Wirkner.
Distils tar with H_2SO_4 to produce pitch.

793,026, June 20, 1905, H. S. Blackmore (to Black-Ford Utility Oil Co.).
Desulfurizes petroleum by treatment with CaC_2 , etc.

807,505, Dec. 19, 1905, A. Schwarz (to Schwarz Ore Treating Co.).
Concentrates ores by mixing with an adhesive agent composed of a hydrocarbon and S.

807,983, Dec. 19, 1905, J. P. Wintz.
Separates asphaltum from crude oil by treating with gasoline and H_2SO_4 .

809,086, Jan. 2, 1906, H. S. Blackmore (to Black-Ford Utility Oil Co.).
Desulfurizes petroleum by treatment with a metal-hydrogen carbide.

809,087, Jan. 2, 1906, H. S. Blackmore (to Black-Ford Utility Oil Co.).
Desulfurizes petroleum by treatment with metal carbonyl.

826,089, July 17, 1906, D. T. Day.
Deodorizes mineral oil by hydrogenating in the presence of a catalyst such as clay.

827,113, July 31, 1906, W. Oppenheimer.
Treats water gas tar with caustic lime.

830,332, Sept. 4, 1906, M. Kuess.
Saponifies with NaOH a mixture of petroleum oil, fat, and resin to produce a soap.

835,120, Nov. 6, 1906, H. L. Sulman, H. F. Kirkpatrick-Picard, and J. Ballot.
Mixes ores with water containing fraction of 1% of H_2SO_4 and agitates the mixture with 0.02% to 0.05% oleic acid.

837,655, Dec. 4, 1906, J. Armstrong, W. E. F. Armstrong, admr.
Agitates petroleum oil with a solution containing $Ca(OCl)_2$, Na_2CO_3 , and $Na_2Cr_2O_7$.

850,898, Apr. 23, 1907, F. Boleg (to Gesellschaft zur Verwertung der Boleg'schen Wasserlöslichen Mineralöle und Kohlenwasserstoffe, G.m.b.H.).
Renders mineral oil water soluble by adding resin oil and treating with alkali.

854,057, May 21, 1907, W. J. Ryan and C. R. Burke.
Prepares lubricating oils by diluting the stock with naphtha, chilling, filtering, and distilling off the naphtha.

864,753, Aug. 27, 1907, F. J. Lothammer and C. Trocquet (61/100 to E. Leon).
Emulsifies petroleum with saponine, ignites the emulsion and boils the residue with a solution of Na silicate, Na_2CO_3 , and saponine.

877,702, Jan. 28, 1908, E. Bryk (to Farb. vorm. Meister Lucius and Brüning).
Prepares dithiosalicylic acid by the action of diazotized anthranilic acid on H_2S , metal sulfhydrates, or metal sulfides.

878,370, Feb. 4, 1908, J. Fischer.
Mixer for treating oil with acid, etc.

893,499, July 14, 1908, B. Homolka and R. Welde (to Farb. vorm. Meister Lucius and Brüning).
Blows air through alkaline solution of orthothioacetophenone to produce dithio-bodies.

899,879, Sept. 29, 1908, T. Macherski and E. Koperski.
Mixes bone black and powdered Zn to prepare an oil decolorizing composition.

901,268, Oct. 13, 1908, H. Terrisse (to The Societe Anonyme de la Thyoleine).
An insecticide consisting of 10 parts of ichthhyol sulfonic acid, 3 parts of glycerine and 10 parts of soap.

901,411, Oct. 20, 1908, E. W. Wynne.
Treats petroleum oil with borax, alum, and $NaCl$ solution, and then adds H_2SO_4 .

901,718, Oct. 20, 1908, K. Lüdecke (to Vereinigte Chemische Werke Actiengesellschaft).
Bleaches fats, mineral oils, etc., by heating with organic superoxides.

908,400, Dec. 29 1908, J. E. Eggleston (to Standard Oil Company of N. J.).
Covers apparatus for desulfurizing petroleum by heating to drive off H_2S .

910,584, Jan. 26, 1909, C. I. Robinson (to Standard Oil Co. of N. J.).
Desulfurizes cracked petroleum distillate by treatment with strong H_2SO_4 .

911,553, Feb. 2, 1909, L. Edelenau.
Treats mineral oil with SO_2 .

913,780, Mar. 2, 1909, E. A. Starke.
Produces CaH_4 or its homologs from petroleum distillate by treating with conc. H_2SO_4 , heating with agitation, settling and recovering C_6H_6 from the sulfonic acids so formed.

922,282, May 18, 1909, M. Isler (to Badische Anilin and Soda Fabrik).
Heats anthracene with S producing a dye.

923,427, **923,428**, **923,429**, June 1, 1909, J. L. Gray.
Treats sludge acids to separate hydrocarbons.

929,503, July 27, 1909, G. B. Selden.
Adds H_2O_2 to motor fuel.

931,520, Aug. 17, 1909, J. Stockhausen.
Emulsion composed of sulfonated oils or fats saponified with at least 6% NaOH and chlorides of hydrocarbons having more than one carbon atom.

951,072, Mar. 1, 1910, A. Heinemann.
Prepares thiophene from laevulinic acid and P_2S_5 . Thiophene and hydrogen passed through a tube or vessel heated to 500°-700° and containing finely divided Cu, Ni, Fe, Ag, or the like, etc., decomposition with the elimination of H_2S .

951,272, Mar. 8, 1910, H. Frasch (to Standard Oil Co. of N. J.).
Treats kerosene distillate with ethyl, methyl, etc., alcohol, and with H_2SO_4 .

955,372, Apr. 19, 1910, H. V. Walker (to The Maas and Waldstein Co.).
Treats oil vapors with anhydrous $CuCl_2$. The treatment may be followed by a doctor treatment.

956,065, Apr. 26, 1910, J. C. Fleming.
Agitator for mixing oil and chemical treating agent.

958,820, May 24, 1910, J. H. Parker.
Passes oil vapors through a mixture of CaO , coke, $NaCl$, Fe_2O_3 , and colemanite.

962,840, June 28, 1910, J. J. Hood and A. G. Salamon (to The Oil Refining Improvements Co., Ltd.).
Decolorizes oil by filtration through MgO .

962,841, June 28, 1910, J. J. Hood and A. G. Salamon (to The Oil Refining Improvements Co., Ltd.).
Decolorizes oil by filtration through Al_2O_3 .

967,337, Aug. 16, 1910, D. T. Day.
Treats asphaltum with HNO_3 to prepare nitro products.

968,640, Aug. 30, 1910, J. C. Black (to Standard Oil Co. of Calif.).
Passes SO_3 obtained by catalytic oxidation of SO_2 through oil and separates the sludge formed.

968,682, Aug. 30, 1910, C. I. Robinson (to Standard Oil Co. of N. J.).
Treats petroleum distillates with 98% H_2SO_4 .

999,611, Aug. 1, 1911, F. H. Walker and C. E. Sohn.
Prepares paint vehicle from oil residuum by treatment with H_2SO_4 .

1,000,646, Aug. 15, 1911, W. O. T. van Tienen (to De Bataafsche Petroleum Maatschappij).
Recover oils from acid tar by dilution with H_2O and heating at a pressure of 7 atm. and at a temperature of 140°-165° C.

1,003,289, Sept. 12, 1911, E. Munch (to Badische Anilin and Soda Fabrik).
Forms 4, 4'-dibromodiphenylsulfide 2, 2'-dicarboxylic acid by adding to diazotized 5-brom-2-aminobenzoic acid a solution of Schlippe's salt ($\text{Na}_2\text{SbS}_4 \cdot 9\text{H}_2\text{O}$). Directions are given.

1,004,632, Oct. 3, 1911, D. T. Day.
Deodorizes mineral oil by hydrogenation in the presence of clay or similar catalyst.

1,010,221, Nov. 28, 1911, J. S. Blowski and A. A. Blowski.
Decomposes sludge acid by heating in presence of organic matter thus producing SO_2 .

1,018,040, Feb. 20, 1912, J. E. Eggleston (to Standard Oil Co. of N. J.).
Removes H_2S by distillation from Beaumont or analogous petroleum, oxidizes the gas and uses the product for H_2SO_4 manufacture.

1,018,374, Feb. 20, 1912, C. I. Robinson (to Standard Oil Co. of N. J.).
Removes S from Beaumont or similar petroleum in the form of H_2S by regulating the distillation temperature.

1,018,971, Feb. 27, 1912, T. S. Hamilton (to The Purified Petroleum Products Co.).
Emulsifies oil with brine and separates by gravity.

1,030,916, July 2, 1912, G. Ornstein.
Prepares $\text{C}_2\text{H}_2\text{Cl}_4$ by $\text{C}_2\text{H}_2 + \text{Cl}$ in the presence of Fe.

1,032,822, July 16, 1912, O. Graul and G. Hanschke (to Badische Anilin and Soda Fabrik).
Halogenates petroleum vapors in the presence of ultra-violet rays.

1,042,915, Oct. 29, 1912, L. Hirschberg (to Chemische Fabrik Westend).
Treats mineral oil with fuming H_2SO_4 with heating.

1,056,262, 1,056,263, 1,056,264, Mar. 18, 1913, J. C. Chisholm.
Treats cottonseed oil with alkaline silicate solution followed by treatment with caustic solution.

1,057,395, Mar. 25, 1913, C. I. Robinson (to Standard Oil Co. of N. J.).
Recover H_2SO_4 from SO_2 evolved in distilling acid sludge.

1,062,973, May 27, 1913, H. S. A. Holt (to Badische Anilin and Soda Fabrik).
Producing compounds resembling rubber by heating isoprene in the presence of about 0.2% of sulfur. Homolog of erythrene gives same result.

1,066,322, July 1, 1913, F. Richter.
Prepares an active carbon to remove odors from oils such as from H_2S .

1,066,971, July 8, 1913, C. W. Adams (by mesne to Adams Grease and Oil Co.).
Lubricating compound adding a minimal amount of S.

1,073,233, Sept. 16, 1913, R. Hense.
Fractionally distils a mixture of heavy hydrocarbon, NaOH , light hydrocarbon, resin, and nitro compounds such as pteric acid, to produce motor fuel.

1,073,605, Sept. 23, 1913, G. H. Hultman.
Desulfurizes coal gas by scrubbing with alcohol.

1,074,633, Oct. 7, 1913, L. Lilienfield.
Prepares diethyl sulfate by distilling $\text{Na}_2\text{C}_2\text{H}_5\text{SO}_4$ in vacuum.

1,075,481, Oct. 14, 1913, D. F. Lasher.
Filters oil through the ashes of rice hulls.

1,079,093, Nov. 18, 1913, J. W. Aylsworth and F. L. Dyer.
Distils heavy residues and the like in the presence of refractory material such as coke or crushed fire brick.

1,080,177, Dec. 2, 1913, C. Still.
Covers an agitator for treating oil with acid, etc.

1,081,801, Dec. 16, 1913, S. Wohle (to The Wohle Mineral Oil Products, Ltd.).
Treats petroleum oils with saponaceous substance prepared from a saponaceous plant such as seaweed, quillai bark, etc.

1,085,708, Feb. 3, 1914, W. Steinkopf.
Passes acetylene with hydrogen over heated pyrites to form S compounds such as thiophene.

1,087,888, Feb. 17, 1914, G. Petroff.
Prepares sulfo-acids by treating mineral oil with H_2SO_4 and extracting with alcohol.

1,092,386, Apr. 7, 1914, W. Pau and P. Eberhardt (to Rutgerswerke-Aktiengesellschaft of Berlin).
Obtains sulfonic acids from acid sludge.

1,092,448, Apr. 7, 1914, M. Melamid.
Treats oil with pyro, meta, etc., H_3PO_4 .

1,092,629, Apr. 7, 1914, E. C. W. A. von Boyen (to Wachs und Cerosinwerke zu Hamburg, J. Schlickum und Co.).
Treats mineral wax with HNO_3 .

1,098,763, June 2, 1914, F. Richter.
Mixes finely divided active carbon with mineral oil and agitates the mixture with O_2 -containing gas.

1,098,764, June 2, 1914, F. Richter.
Treats liquid hydrocarbons with lye, adds finely divided active carbon and treats with O_2 -containing gas.

1,099,622, June 9, 1914, O. J. Shiner, dec'd., M. E. Shiner, exrx.
Treats countercurrent with a down current of acid or other chemical treating agent, the flow of treating agent being in alternate gravity and centrifugal motion steps.

1,101,375, June 23, 1914, E. Wolf [to Chinoim Gyogyszeres Vegyeszeti Termeket Gyara R. T. (Dr. Kereszty es Dr. Wolf)].
Produces aliphatic alkyl sulfates by treating aliphatic ethers with sulfuric acid chlorhydrin (chlorsulfonic acid).

1,102,696, July 7, 1914, O. J. Shiner, M. E. Shiner, admrx.
Covers a mixer for treating oil with chemicals.

1,104,906, July 28, 1914, B. Lach.
Treats petroleum with steam and HCHO and then with H_2 .

1,105,744, Aug. 4, 1914, C. Baskerville.
Refines saponifiable oil by treating with vegetable fibers impregnated with alkali.

1,108,351, Aug. 25, 1914, R. de Fazi.
Mixes tar oil with crude or shale oil and treats with H_2SO_4 and CaO .

1,109,187, Sept. 1, 1914, E. A. Starke.
Saturates petroleum distillate with SO_2 and treats with H_2SO_4 .

1,110,925, Sept. 15, 1914, C. J. Greenstreet.

Oxidizes olefins in cracked vapors by means of HOCl, H₂SO₄, or the like.

1,111,580, Sept. 22, 1914, S. M. Herber.

Mixes lime with oil and distils with steam. Air may be introduced with the steam.

1,112,602, Oct. 6, 1914, J. Dehnst.

Adds S to mineral oil, distils off a portion before H₂S is evolved, and heats the remainder until H₂S ceases to be evolved.

1,114,045, Oct. 20, 1914, H. W. Robinson.

Injects a mixture of formalin and steam into the still in which tar or pitch is being distilled.

1,114,095, Oct. 20, 1914, C. Baskerville.

Bleaches oils and fats by treatment with an inorganic absorbent, an organic absorbent, and an electrolyte.

1,125,422, Jan. 19, 1915, S. W. Whitmore.

Distils hydrocarbon oils after adding naphthalene.

1,131,880, Mar. 16, 1915, C. H. Warth.

Passes kerosene through a steam heated coil and sweetens before blending with benzol to prepare motor fuel.

1,140,865, May 25, 1915, R. F. Bacon (to Metals Research Co.).

Separates sulfide minerals from associated gangue by subjecting the mixture in finely divided condition to the flotation action of colloidal S.

1,148,011, July 27, 1915, G. L. Davies and W. E. W. Richards.

Separates lighter from heavier oils in coal tar by acidulating with about 3% of H₂SO₄, adding about 4% of light mineral oil, settling, and decanting. The mixture may be aerated to remove S compounds.

1,115,523, Aug. 24, 1915, J. J. Hood and A. G. Salamon (to The Oil Refining Improvements Co.).

Decolorizes oil by filtering through magnesite rendered anhydrous by heating to dull red heat.

1,152,478, Sept. 7, 1915, J. C. Black (to Standard Oil Co. of Calif.).

Refines oil by treatment with gaseous SO₂.

1,152,765, Sept. 7, 1915, P. Sabatier and A. Mailhe (to Societe des Raffineries Catalytiques des Petroles et Hydrocarbures of Paris).

Decomposes catalytically hydrocarbons of high boiling point to those of lower.

1,154,516, Sept. 21, 1915, E. D. Kendall (1/3 to L. T. Hagggin, M. V. Hagggin, A. McCulloh, and H. E. Moller, exrs. of J. B. Hagggin dec'd, and 1/3 to estate of W. A. McGrath).

Covers a method of treating oil with H₂SO₄.

1,154,517, Sept. 21, 1915, E. D. Kendall (1/3 to L. T. Hagggin, M. V. Hagggin, A. McCulloh, and H. E. Moller, exrs. of J. B. Hagggin, dec'd, and 1/3 to estate of W. A. McGrath).

Treats oil with H₂SO₄ in horizontal, rotating conical chambers filled with granular material.

1,157,988, Oct. 26, 1915, H. Koppers (to H. Koppers Co.).

Agitator for treating C₆H₆ with H₂SO₄.

1,158,205, Oct. 26, 1915, T. T. Gray.

Heats mineral oil with clay or other catalytic agent and blows with O₂ containing gas to debloom.

1,158,367, Oct. 26, 1915, G. Blieberger.

Distils kerosene mixed with methyl alcohol, acetone, PbCO₃, and sylvic acid to produce motor fuel.

1,163,025, Dec. 7, 1915, F. W. Mann and M. L. Chappell (to Standard Oil Co. of Calif.).

Treats petroleum oils with alcohol at temperatures below 32° F.

1,164,162, Dec. 14, 1915, J. C. Black (to Standard Oil Co. of Calif.).

Treats petroleum with gaseous SO₂.

1,170,468, Feb. 1, 1916, E. Twitchell.

A sulfonic material for the manufacture of glycerine and fatty acids from fats and oils.

1,170,637, Feb. 8, 1916, A. H. Higgins (to Minerals Separation American Syndicate, Ltd.).

Treats organic compounds such as fats, oils, alcohols, phenols, or their homologs with H₂SO₄ and use this product for ore flotation.

1,170,665, Feb. 8, 1916, E. H. Nutter (to Minerals Separation American Syndicate, Ltd.).

Concentrates ores by adding a minute quantity of a hydrocarbon with H₂SO₄.

1,171,434, Feb. 15, 1911, G. E. Heyl and T. T. Baker.

Treats coal tar middle oil with caustic followed by H₂SO₄ and water wash to obtain material for blending in motor fuels.

1,175,910, Mar. 14, 1916, W. A. Hall.

Describes the clarification of petroleum distillate by distillation in the presence of fullers earth or the like.

1,183,749, May 16, 1916, M. Melamid.

Distils tar or tar oil in the presence of phosphorus compounds other than H₃PO₄.

1,185,747, June 6, 1916, J. N. Wingett (to W. A. Haggott, trustee).

Adds HNO₃ to a mixture of kerosene and toluene or similar nitratable compound and distils to produce a motor fuel.

1,186,373, June 6, 1916, J. S. Blowski and A. A. Blowski.

Recovers acid from sludge acid by diluting to separate organic matter and then distilling the water solution rapidly to obtain H₂SO₄ and some SO₂.

1,187,797, June 20, 1916, D. M. Allan, Jr. (to Standard Oil Company of N. J.).

Method and apparatus for treating oil with acid and alkali and for recirculating both oil and treating agent.

1,188,961, June 27, 1916, H. T. Maitland (to Sun Oil Co.).

Treats lubricating distillates with H₂SO₄ and then with NH₃ without first permitting complete settlement.

1,194,033, Aug. 8, 1916, H. W. Knottenbelt.

Treats oil distillate with NO and then with FeSO₄ solution.

1,196,274, Aug. 29, 1916, G. Petroff (to Aktions Company "Kontakt").

Prepares sulfonate soaps from mineral oil acid sludge.

1,197,599, Sept. 12, 1916, B. T. Brooks and F. W. Padgett (to Gulf Refining Co.). Chlorinates solar oil and then dissociates the dichloride formed in the presence of BaCl_2 as a catalyst, to produce drying oils.

1,201,601, Oct. 17, 1916, M. Melamid. Distils tar or tar oil in the presence of H_3PO_4 .

1,205,578, Nov. 21, 1916, H. Strache and P. Porges. Passes oil vapors and steam over metallic oxide.

1,206,962, Dec. 5, 1916, J. M. Weiss (to The Barrett Co.). Treats aromatic hydrocarbons with aqueous metallic sulfate solution.

1,207,798, Dec. 12, 1916, A. P. Sachs and O. Byron. Produces sodium sulfonate by treating an aqueous solution of calcium sulfonate with Na_2SO_4 .

1,210,725, Jan. 2, 1917, D. Tyrer. Sulfonates hydrocarbons boiling below 200°C. by heating with H_2SO_4 and removing the water formed as the reaction proceeds.

1,214,919, Feb. 6, 1917, H. Hibbert, H. Essex, and B. T. Brooks (to Gulf Refining Co.). Treats petroleum distillates containing pentanes and hexanes with Cl_2 and hydrolyzes the Cl_2 products to produce alcohols.

1,215,732, Feb. 13, 1917, W. O. Snelling (51/100 to J. T. Milliken). Desulfurizes hydrocarbons by distilling in the presence of a heavy cracked oil capable of absorbing the S.

1,218,713, Mar. 13, 1917, H. Stern. Makes vulcanized caoutchouc-like bodies by reacting SCl_2 with a ketone capable of yielding isoprene.

1,221,698, Apr. 3, 1917, D. T. Day. Adds S to mineral oil, distils while passing through the oil, and superheats the vapors in the presence of porous absorptive substances.

1,224,485, May 1, 1917, G. Mersereau (to Chemical Development Co.). Treats gas from a cracking process with Cl_2 .

1,233,700, July 17, 1917, G. Petroff (to Twitchell Process Co.). Treats mineral oil with acid, removes sludge, and treats with aqueous alc. alkali.

1,234,862, July 31, 1917, A. L. Brown (to Westinghouse Electric and Manufacturing Co.). Treats hydrocarbon oil with P.

1,236,031, Aug. 7, 1917, E. H. Wright and J. F. Oakleaf (to Vacuum Oil Co.). Adds lime or some reagent to waste acid sludges to precipitate dissolved materials, then treats precipitate to recover any petroleum held.

1,236,857, Aug. 14, 1917, R. B. Martin (to Minerals Separation North American Corp.). Prepares oil for ore flotation by distilling pine oil with S.

1,239,099, Sept. 4, 1917, W. A. Hall. Removes gum-forming constituents from cracked gasoline by distilling with fullers earth, filtering or acid treating.

1,239,100, Sept. 4, 1917, W. A. Hall. Distils cracked gasoline in the presence of fullers earth to clarify and deodorize.

1,240,523, Sept. 18, 1917, A. Wolff. Prepares sulfonic acids and sulfonates from mineral oil sludge.

1,240,792, Sept. 18, 1917, H. V. Dunham (to Hall Motor Fuel, Ltd.). Produces paraffinum liquidum by treating petroleum distillate with acid, removing sludge, treating with NH_3 and alcohol, and filtering.

1,246,671, Nov. 13, 1917, F. W. Sperr, Jr. (to H. Koppers Co.). Treats coke oven distillates with H_2SO_4 and distils to obtain pure fractions.

1,247,499, Nov. 20, 1917, H. Bull. Sulfonates aromatic hydrocarbons with H_2SO_4 in continuous countercurrent process.

1,250,879, Dec. 18, 1917, L. E. Hirt. Supplies halogen gas to distillation vapors.

1,252,481, Jan. 8, 1918, R. B. Parker (to Semet-Solvay Co.). Treats condensate from distilling absorbent saturated with gases with H_2SO_4 .

1,253,048, Jan. 8, 1918, H. B. Kipper. Removes CS_2 from C_6H_6 by treatment with NaOH and cellulose.

1,257,829, Feb. 26, 1918, E. V. Evans. Desulfurizes coal tar naphtha by heating with H_2 in the presence of a catalyst.

1,263,289, Apr. 16, 1918, F. C. Ruff (to By-Products Manufacturing Co.). Treats gasoline with nitro-sulfuric acid to remove unsaturated hydrocarbons.

1,270,759, June 25, 1918, H. Hilbert. Heats oil gas to 600°-900° C., treats the resulting product with Cl_2 and saponifies the resulting products to obtain glycols.

1,271,387, July 2, 1918, R. de M. Taveau (to The Atlantic Refining Co.). Outlines method of obtaining sulfonic acids from acid sludge.

1,272,979, July 16, 1918, H. T. Maitland (to Sun Oil Co.). Mixes oil and acid in a jet.

1,274,912, Aug. 6, 1918, W. F. M. McCarty. Treats petroleum oils with superheated steam under 150 lb. pressure in the presence of a water soluble Al compound. The oil is then settled, decanted, and vaporized, and the vapors treated at 600°C. with H_2 in the presence of a catalyst.

1,276,284, Aug. 20, 1918, James E. Thompson. Removes CS_2 , H_2S , and sulfocyanide compounds from aromatic hydrocarbons by treatment with aqueous NH_3 solution.

1,276,822, Aug. 27, 1918, J. Stewart (to E. I. DuPont de Nemours and Co.). Treats mineral oil alkali sludge with acid sulfite.

1,277,092, Aug. 27, 1918, A. M. McAfee (to Gulf Refining Co.). Heats paraffin to 150°F. with AlCl_3 .

1,277,328, Aug. 27, 1918, A. M. McAfee (to Gulf Refining Co.). Heats kerosene at 150°F. with AlCl_3 .

1,277,329, Aug. 27, 1918, A. M. McAfee (to Gulf Refining Co.).

Prepares medicinal oils by heating with AlCl_3 .

1,277,605, Sept. 3, 1918, H. W. Knottenbelt.

Neutralizes acid treated oil with an alkaline solution of litmus.

1,279,295, 1,279,296, Sept. 17, 1918, C. R. Downs (to The Barrett Co.).

Sulfonates hydrocarbons and their derivatives under vacuum to remove H_2O from the reaction mixture.

1,280,178, Oct. 1, 1918, D. T. Day (to V. Z. Reed).

Extracts shale with a mixture of solvent and acid.

1,281,354, Oct. 15, 1918, J. O. Handy (to Pittsburgh Testing Laboratory).

Centrifuges used lubricating oil, dilutes with naphtha or the like, filters, treats with acid, and removes the solvent.

1,281,355, Oct. 15, 1918, J. O. Handy (to Pittsburgh Testing Laboratory).

Treats used lubricating oils by diluting with gasoline or similar solvent, filters, and treats with alkali, and then removes the solvent.

1,284,750, Nov. 12, 1918, A. G. Munro (to Refiners Engineering and Supply Co.).

Treats oil with "earth sludge" and filters in a special apparatus.

1,286,179, Nov. 26, 1918, R. E. Humphreys (to Standard Oil Co. of Indiana).

Treats with acid, neutralizes and extracts the neutralized oil with a water soluble solvent such as alcohol.

1,295,308, Feb. 25, 1919, J. O. Handy (to Pittsburgh Testing Laboratory).

Treats used lubricants with clarifying and decolorizing agents, removes water with a dry powder, treats with H_2SO_4 , and neutralizes.

1,296,244, Mar. 4, 1919, W. C. and F. E. Wells.

Distils petroleum over a molten metal bath.

1,297,328, Mar. 18, 1919, M. Darrin (to H. Koppers Co.).

Treats crude solvent naphtha with H_2SO_4 to produce polymerized resins. Cf. also 1,263,813 and 1,326,579.

1,297,388, Mar. 18, 1919, C. L. E. Mueller.

Treats light oils from coal tar with NaNO_2 before blending with petroleum distillates to produce a fuel.

1,300,816, Apr. 15, 1919, E. B. Cobb (to Standard Oil Co. of N. J.).

Desulfurizes mineral oil by treatment with an alkaline sulfide in alkaline solution.

1,301,662, Apr. 22, 1919, R. E. Divine.

Prepares sulfonic acids from petroleum or petroleum products.

1,301,663, Apr. 22, 1919, R. E. Divine.

Preparation of Ca sulfonate and a method of separating sulfonic acids.

1,301,785, Apr. 22, 1919, C. R. Downs (to The Barrett Co.).

Sulfonates hydrocarbons and their derivatives under vacuum to remove H_2O from the reaction mixture.

1,301,796, Apr. 22, 1919, J. M. Weiss (to The Barrett Co.).

Treats carbazol with H_2SO_4 at below 35° C.

1,303,779, May 13, 1919, R. E. Devine (to The Twitchell Process Co.).

Prepares sulfonic acids from the sludge obtained by treating petroleum with H_2SO_4 .

1,305,870, June 3, 1919, M. W. Blyth and T. V. Miles.

Covers a method and apparatus for treating C_6H_6 with H_2SO_4 .

1,309,432, July 8, 1919, R. H. Brownlee.

Treats heated oil with a polymerizing agent such as AlCl_3 to produce lubricating oils.

1,310,164, July 15, 1919, E. H. Leslie (to General Petroleum Corp.).

Forces treating reagent downwardly through the oil in a confined vessel, withdraws sludge at the bottom and oil at the top, and recirculates them.

1,311,848, July 29, 1919, P. Lepers.

Separates m-xylene from xylene substances by treatment with H_2SO_4 .

1,312,375, Aug. 5, 1919, J. C. Whitman (1/2 to H. G. Whitman).

Filters oil through bog iron ore.

1,313,629, Aug. 19, 1919, C. K. Francis and D. G. Morgan (to Cosden and Co.).

Mixes hydrocarbon oil with a saponaceous mixture containing excess alkali and distils.

1,315,623, Sept. 9, 1919, E. B. Cobb (to Standard Oil Co. of N. J.).

Treats oil with glycerine after acid and alkali treatments.

1,316,823, Sept. 23, 1919, J. A. Ambler, H. A. Lubs, and H. D. Gibbs.

Prepares sulfonic acids from cymene by treating with H_2SO_4 in the vapor phase.

1,317,582, Sept. 30, 1919, H. W. Knottenbelt.

Treats motor fuel distillate with H_2SO_4 and then neutralizes in the presence of C_6H_6 or similar solvent.

1,317,648, Sept. 30, 1919, T. H. Durrans (to A. Boake, Roberts and Co., Ltd.).

Treats CH_3OH with SO_2 and Cl_2 in specified proportions to produce $(\text{CH}_3)_2\text{SO}_4$, CH_3HSO_4 , and CH_3Cl .

1,317,868, Oct. 7, 1919, C. Ellis (to Ellis-Foster Co.).

Treats cracked products with Cl_2 and then with a reagent capable of replacing the Cl_2 .

1,318,061, Oct. 7, 1919, C. Ellis (to Ellis-Foster Co.).

Treats cracked distillate with dilute H_2SO_4 .

1,319,027, Oct. 14, 1919, R. E. Divine (to The Twitchell Process Co.).

Produces sludge sulfonic acids and method of separation.

1,320,396, Nov. 4, 1919, W. G. Laird (to H. L. Doherty).

Passes oil through moving layers of treating liquid.

1,324,649, Dec. 9, 1919, H. V. Dunham.

Passes hydrocarbon vapors containing di-enes through heated bauxite, fullers earth, etc., to effect polymerization.

1,324,715, Dec. 9, 1919, C. E. Andrews (to The Selden Co.).

Oxidizes aromatic hydrocarbons by heating with H_2SO_4 and a catalyst such as Va or Mn compounds.

1,325,668, Dec. 23, 1919, R. Fleming (to The Richard Fleming Co.).
Passes cracked vapors into water under pressure to remove S compounds.

1,326,072, Dec. 23, 1919, A. M. McAfee (to Gulf Refining Co.).
Heats gasoline in the presence of $AlCl_3$.

1,330,624, Feb. 10, 1920, R. E. Divine (to The Twitchell Process Co.).
Prepares water-soluble sulfonic acids and water-soluble calcium and barium sulfonates from sludge acids.

1,332,359, Mar. 2, 1920, R. R. Rosenbaum (to Central Commercial Co.).
Heats bitumen under pressure in the presence of an alkali and a metal to hydrogenate.

1,336,207, Apr. 6, 1920, J. A. de Crew.
Uses a sulfonated oil to prepare a stable emulsion.

1,337,523, Apr. 20, 1920, E. H. Leslie and C. Barbre (to General Petroleum Corp.).
Heats and agitates cracked oils with a porous catalyst (kieselguhr, etc.) and a neutralizing agent ($CaCO_3$, etc.), filters and distils.

1,339,727, May 11, 1920, J. W. Trotter.
Treats kerosene at $125^{\circ} F$. with fuming H_2SO_4 and gasoline with caustic.

1,339,947, May 11, 1920, H. R. Curme (to Union Carbide Co.).
Produces alkyl sulfate by controlling the concentrations in the absorption of C_2H_4 in H_2SO_4 .

1,340,889, May 25, 1920, T. T. Gray.
Passes distillation vapors through fullers earth or the like.

1,343,100, June 8, 1920, E. W. Thurlow.
Mixes shale with limestone or the like which produces CO_2 during distillation. At the close of the run, moisture is introduced into the hot mass.

1,344,671, June 29, 1920, F. Bergius (to The Chemical Foundation, Inc.).
Heats mineral oil with H_2 under pressure.

1,349,294, Aug. 10, 1920, W. B. Price and E. Dietz.
Passes cracked vapors through trays filled with metallic oxide before condensing.

1,349,909, Aug. 17, 1920, W. B. Pratt (to E. H. Clapp Rubber Co.).
Prepares a sulfur-terpene compound.

1,350,408, Aug. 24, 1920, M. Hartman and E. Wybert (to Society of Chemical Industry in Basle).
Prepares thiénylquinoline carboxylic acids.

1,351,047, Aug. 31, 1920, M. Leitch (to The DeLaval Separator Co.).
Reclaims used gasoline by treatment with alkaline solution and centrifuging.

1,353,220, Sept. 21, 1920, H. N. Copthorne and A. L. Tannehill.
Produces artificial resin by treating coal tar distillate with H_2SO_4 .

1,357,224, Nov. 2, 1920, E. B. Cobb (to Standard Oil Co. of N. J.).
Removes elementary S from mineral oil by treatment with alkaline hydroxide and H_2S .

1,357,225, Nov. 2, 1920, E. B. Cobb (to Standard Oil Co. of N. J.).
Desulfurizes mineral oil by treatment with alkaline earth sulfide.

1,358,490, Nov. 9, 1920, M. Wyler (to Levinstein, Ltd.).
Heats acenaphthene mixed with 3.5 parts of S at 250° - $300^{\circ} C$. Yields dye. (Compare *Ber. 36*, 962 and 1583 where dinaphthylthiophene and trinaphthylbenzene are prepared by same method but with less sulfur).

1,359,614, Nov. 23, 1920, J. R. Miller.
Reclaims crank case oil by treating with steam and soap solution.

1,360,153, Nov. 23, 1920, Y. Tanaka (to The Naniwa Grease Kabushiki-Kaisha).
Treats a mixture of pine root and mineral oils with acid and alkali to produce grease.

1,360,665, Nov. 30, 1920, S. P. Miller (to The Barrett Co.).
Polymerizes indene in naphtha solution by treating with $AlCl_3$ at below $20^{\circ} C$.

1,363,784, Dec. 28, 1920, C. H. Hapgood (to The De Laval Separator Co.).
Reclaims crank case oil by adding a saponifiable oil, treating with alkali, and centrifuging.

1,365,043, Jan. 11, 1921, M. D. Mann, Jr. and R. R. Williams (by mesne to S. B. Hunt, trustee).
Absorbs olefins in H_2SO_4 to prepare "reactive acid liquor."

1,365,044, Jan. 11, 1921, C. Ellis (to S. B. Hunt, trustee).
Uses the acid extract obtained by treating a mixture of olefins and liquid saturated hydrocarbons with H_2SO_4 in the treatment of additional olefin material so as to obtain an acid liquor highly saturated with olefins.

1,365,045, Jan. 11, 1921, M. D. Mann, Jr. (to S. B. Hunt, trustee).
Treats gasoline with dilute H_2SO_4 to remove unsaturated compounds.

1,365,046, Jan. 11, 1921, C. Ellis (to S. B. Hunt, trustee).
Treats cracked gasoline, etc., with H_2SO_4 and hydrolyzes the product to obtain alcohols which are then separated by means of a solvent.

1,365,047, Jan. 11, 1921, M. J. Cohen, G. Cohen, A. Breslauer, H. Asher, exrs. of said M. J. Cohen, dec'd. (by mesne to S. B. Hunt, trustee).
Purifies alcoholic materials by distilling in the presence of a small quantity of H_2SO_4 .

1,365,048, Jan. 11, 1921, C. Ellis and M. J. Cohen (to S. B. Hunt, trustee).
Treats cracked gasoline, etc., with H_2SO_4 and hydrolyzes the product to obtain alcohols.

1,365,050, Jan. 11, 1921, C. Ellis and M. J. Cohen (to S. B. Hunt, trustee).
Prepares ester bodies from unsaturated hydrocarbons with H_2SO_4 .

1,365,053, Jan. 11, 1921, C. Ellis and A. A. Wells (to S. B. Hunt, trustee).
Produces ketones by treating unsaturated hydrocarbons with H_2SO_4 of 1.8 sp. gr. under sulfating conditions, extracting, and electrolytically oxidizing extract.

1,365,423, Jan. 11, 1921, S. P. Miller and F. H. Rhodes (to The Barrett Co.).
Polymerizes coal tar distillate with H_2SO_4 to produce resins, washes, neutralizes, and treats with HCl .

1,365,894, Jan. 18, 1921, D. T. Day.
Treats oil with CuCl.

1,367,428, Feb. 1, 1921, G. W. Pressell (to E. F. Houghton and Co.).
Cuts oil containing sulfur.

1,370,367, Mar. 1, 1921, R. E. Sayre (to Metals Recovery Co.).
Prepares thioaldehydes and their use in flotation.

1,370,494, 1,370,495, Mar. 1, 1921, J. E. Hutchinson (to J. F. Henderson).
Purifies gas by passing through bed of Fe filings or any form of Fe to give large surface.

1,375,506, Apr. 19, 1921, E. D. Gray (to Standard Oil Co. of Calif.).
Covers a centrifugal separator for separating sulfonic acid, etc.

1,375,975, Apr. 26, 1921, A. Romer (to A. Kuttroff).
Converts sulfonic acids of α - and β -oxynaphthalene into condensation products by heating with a condensing agent such as H_2SO_4 .

1,384,423, July 12, 1921, E. Bielouss (to H. A. Gardner).
Prepares drying oil from petroleum by chlorination followed by dechlorination.

1,385,036, 1,385,037, July 19, 1921, W. N. Blakeman, Jr.
Hydrogenates and oxidizes a Texas oil.

1,385,515, July 26, 1921, Re **15,211**, Oct. 25, 1921, C. A. Basore.
Hydrolyzes ethyl hydrogen sulfate with 50% excess H_2O under pressure and with heat and distils off the alcohol.

1,387,835, Aug. 16, 1921, E. B. Cobb (to Standard Oil Co. of N. J.).
Treats oil in successive steps with H_2SO_4 , with removal of sludge between steps, and extracts with isopropyl alcohol.

1,387,868, Aug. 16, 1921, C. I. Robinson (to Standard Oil Co. of N. J.).
Treats lubricating oil in successive steps with concentrated and fuming H_2SO_4 , neutralizes, and extracts with isopropyl alcohol.

1,388,415, Aug. 23, 1921, C. Ekstrand, M. Ekstrand, exrx.
Passes vapors from a dephlegmator through bauxite, fullers earth, or the like.

1,388,517, Aug. 23, 1921, E. B. Cobb (to Standard Oil Co. of N. J.).
Treats mineral oil with H_2SO_4 , removes sludge, distils with steam, treats with acid, and filters through solid decolorizing material.

1,388,832, Aug. 23, 1921, E. B. Cobb (to Standard Oil Co. of N. J.).
Treats mineral oil with successive batches of H_2SO_4 , with removal of sludge between treatments, and finally filters the acid-treated oil through solid decolorizing material.

1,388,868, Aug. 30, 1921, F. B. Jones and E. Bury (to Minerals Separation North American Corp.).
Uses sulfo-cresols in ore flotation.

1,389,791, Sept. 6, 1921, A. L. Tannehill.
Polymerizes solvent naphtha with H_2SO_4 .

1,392,370, Oct. 4, 1921, J. M. Treneer and C. S. Benjamin (to A. J. Doremus and H. G. Turner).
Treats paraffin with benzol containing SO_2 .

1,394,481, Oct. 18, 1921, J. T. Fenton.
Passes uncondensed vapors from a cracking process through H_2SO_4 absorbers for converting the olefins into alkyl derivatives, from which alcohols may be obtained by hydrolysis.

1,394,486, Oct. 18, 1921, A. B. Foster.
Mixes oil and treating agent in jets directed against a baffle.

1,394,987, Oct. 25, 1921, R. Fleming (to The Richard Fleming Co.).
Covers apparatus for scrubbing vapors with chemical solutions during condensation.

1,395,968, Nov. 1, 1921, S. P. Miller (to The Barrett Co.).
Polymerizes solvent naphtha with $AlCl_3$, H_2SO_4 , etc.

1,396,399, Nov. 8, 1921, O. E. Bransky (to Standard Oil Co. of Indiana).
Purifies acid-treated oil by extraction with an aqueous solution of green sulfonated mineral oil.

1,396,999, Nov. 15, 1921, C. Ellis.
Removes catalyst poisons from cracked gasoline and hydrogenates.

1,399,238, Dec. 6, 1921, G. P. Adamson (to General Chemical Co.).
Prepares alkyl sulfuric acid by treating alkyl alcohol with SO_3 under specified conditions.

1,400,419, Dec. 13, 1921, H. P. Chamberlain (to Standard Oil Co. of N. Y.).
Treats kerosene distillate with acid before redistillation.

1,400,800, Dec. 20, 1921, J. W. Coast, Jr. (to The Process Co.).
Treats steam still condensate with acid.

1,401,693, Dec. 27, 1921, W. N. Haworth and J. C. Irvine.
Prepares $(CH_3)_2SO_4$ by directly combining $(CH_3)_2O$ with SO_3 .

1,401,760, Dec. 27, 1921, H. C. Claflin.
Screw-cutting compound containing substantial amounts of S.

1,402,733, Jan. 10, 1922, C. M. Alexander (to Gulf Refining Co.).
Treats petroleum oil with H_2SO_4 with or without an additional oxidizing agent and with mechanical agitation.

1,404,293, Jan. 24, 1922, J. J. Hood (to The Oil Refining Improvements Co., Ltd.).
Desulfurizes hydrocarbon oil by passing the vapors over MgO and then over Fe_2O_3 or similar absorber for S compounds.

1,404,294, Jan. 24, 1922, J. J. Hood (to The Oil Refining Improvements Co., Ltd.).
Desulfurizes hydrocarbon oil by passing the vapors over Al_2O_3 and then over Fe_2O_3 or other absorber of S compounds.

1,404,374, Jan. 24, 1922, M. L. Chappell and M. M. Moore (to Standard Oil Co. of Calif.).
Heats oil with clay to 250° F., cools and filters.

1,404,375, Jan. 24, 1922, M. L. Chappell and M. M. Moore (to Standard Oil Co. of Calif.).

Heats oil containing H_2O with clay to 250° F, cools and filters.

1,404,389, Jan. 24, 1922, R. W. Hanna (to Standard Oil Co. of Calif.).

Treats viscous petroleum distillate with H_2SO_4 in a closed container out of contact with air and at a constant temperature.

1,407,770, Feb. 28, 1922, A. S. Ramage (to Bostaph Engineering Corp.).

Treats hydrocarbons containing olefins with H_2SO_4 and recovers the acid derivatives by hydrolysis and distillation.

1,408,320, Feb 28, 1922, C. Weizmann and D. A. Legg.

Converts normal butenes into the corresponding secondary butyl alcohols by absorbing in 75% H_2SO_4 and distilling the resulting liquor with steam.

1,409,404, Mar. 14, 1922, A. S. Ramage (to F. F. Beal, A. S. Ramage and B. Briscoe, trustees known as Chemical Research Syndicate, Ltd.).

Passes petroleum vapors with steam over heated Fe_2O_3 to prepare motor fuel.

1,409,590, Mar. 14, 1922, F. Salathé (½ to The Western Gas Construction Co.).

Treats sludge acids to obtain sulfonated hydrocarbons.

1,411,215, Mar. 28, 1922, E. Kuh.

Prepares neutral alkyl esters of H_2SO_4 by distilling the acid ester under vacuo in the presence of dry neutral Na_2SO_4 .

1,411,237, Mar. 28, 1922, D. T. Day.

Passes oil vapors through sludge acid to remove N compounds.

1,413,005, Apr. 18, 1922, E. B. Cobb (to Standard Oil Co. of N. J.).

Desulfurizes petroleum oils by treating with alkali.

1,413,899, Apr. 25, 1922, E. M. Clark (to Standard Oil Co. of N. J.).

Passes petroleum oil under pressure through the treating agent, and varies the pressure in the treating stage to control the proportions of gas and liquid treated therein.

1,416,062, May 16, 1922, L. Rabinovitz (to Ellis-Foster Co.).

Treats the 160°-180° C. fraction of solvent naphtha with a polymerizing agent such as $AlCl_3$ or H_2SO_4 to prepare coumarone resin.

1,416,291, May 16, 1922, A. Hayes (to U. S. Industrial Alcohol Co.).

Passes a mixture of hydrocarbon vapors and alcohol through a heated aluminum compound catalyst to prepare motor fuel.

1,418,368, June 6, 1922, C. Ellis (to S. B. Hunt, trustee).

Treats diluted acid extract of olefins of cracked petroleum with HNO_3 .

1,418,781, June 6, 1922, S. H. Diggs (to Standard Oil Co. of Indiana).

Mixes petroleum-oil sludge with heavy petroleum oil, water, and mineral-oil sulfonic acid, heats and allows to stratify.

1,421,743, July 4, 1922, B. C. Stuer and W. Grob (to The Chemical Foundation, Inc.).

Among other claims passes C_2H_2 and H_2S over bauxite at 320° to prepare thiophene.

1,422,564, July 11, 1922, A. R. Grob and C. C. Adams (to E. I. Du Pont de Nemours and Co.).

Sulfonates hydrocarbons by use of SO_3 in an atmosphere of SO_2 .

1,423,064, July 18, 1922, O. P. Amend.

Cracks mineral oil vapors in the presence of carbon, clay, metal filings, oxides, etc., to prepare motor fuel.

1,423,710, July 25, 1922, J. C. Clancy (to The Nitrogen Corp.).

Treats mineral oil with liquid NH_3 .

1,423,711, July 25, 1922, J. C. Clancy (to The Nitrogen Corp.).

Desulfurizes mineral oil with liquid NH_3 .

1,423,712, July 25, 1922, J. C. Clancy (to The Nitrogen Corp.).

Desulfurizes mineral oil by treating hot with NH_3 vapor and steam.

1,425,882, **1,425,883**, Aug. 15, 1922, H. T. Maitland (to Sun Oil Co.).

Process of making water insoluble saponifiable oil from the sludge produced in the treatment of mineral oil stock with mineral acid.

1,425,884, Aug. 15, 1922, H. T. Maitland (to Sun Oil Co.).

Describes acid and clay treatment of mineral oil in the manufacture of low sulfur lubricating oil.

1,425,885, Aug. 15, 1922, H. T. Maitland (to Sun Oil Co.).

Treats mineral oil with H_2SO_4 .

1,426,430, Aug. 22, 1922, H. Weyland, H. Hahl, and R. Berendes (to Farbenfabriken vorm. F. Bayer and Co.).

Treats xylene with S and $AlCl_3$; compound to prevent scabies.

1,427,215, Aug. 29, 1922, L. Lilienfeld.

Prepares dialkyl sulfates by the action of SO_3 on aliphatic alcohols in the presence of a dehydrating agent such as Na_2SO_4 .

1,427,182, Aug. 29, 1922, H. Weyland, H. Hahl, and R. Berendes (to Farbenfabriken vorm. F. Bayer and Co.).

Treats toluene with S and $AlCl_3$.

1,427,386, Aug. 29, 1922, S. Hilpert (to himself and Deutsch Luxemburgische Bergwerks und Hütten, A. G.).

Recovers polymerized resins from H_2SO_4 by extraction with aromatic hydrocarbons.

1,428,197, Sept. 5, 1922, A. Wolff (to The Chemical Foundation, Inc.).

Process of cleaning sulfonic acids by removing inorganic salts with 40% to 50% H_2SO_4 .

1,428,885, Sept. 12, 1922, A. Hayes (to U. S. Industrial Alcohol Co.).

Passes vapors from a mixture of petroleum distillate and alcohol through a heated catalyst of Ni or Zn.

1,429,932, Sept. 26, 1922, A. Deschauer. Chlorinates Montau wax in aqueous solution.

1,430,882, Oct. 3, 1922, W. N. Blakeman, Jr.

Hydrogenates and oxidizes Pennsylvania oil.

1,431,246, Oct. 10, 1922, W. Münder (to The Chemical Foundation, Inc.).

Distils heavy hydrocarbons at 300° C. and one atm. pressure and subjects the condensate to continuous distillation at superatmospheric pressure.

1,431,259, Oct. 10, 1922, C. I. Robinson (to Standard Oil Co. of N. J.).

Washes light petroleum product with sulfuric acid (90%), separates and dilutes acid at once. Alcohols formed on dilution.

1,433,052, Oct. 24, 1922, W. C. and F. E. Wells.

Passes distillation vapors through filtering material such as fullers earth. Molten metal is also present in the still.

1,434,300, Oct. 31, 1922, C. L. Lightenhome (to Lightenhome Oil and Refining Co.).

Distils with steam in the presence of CaO.

1,435,824, Nov. 14, 1922, A. E. Dunstan.

Removes sulfides, polysulfides, and hydro-sulfides by use of an alkaline solution of hypochlorite.

1,436,136, Nov. 21, 1922, E. Zerner.

Oxidizes liquid hydrocarbons, separating the undissolved residue and blowing with O₂ after evaporating off the SO₂.

1,436,214, Nov. 21, 1922, G. Teichner.

Treats mineral oil with H₂SO₄ before subjection to catalytic oxidation.

1,436,288, Nov. 21, 1922, H. Plauson.

Prepares vinyl sulfuric acid by treating C₂H₂ with H₂SO₄ under pressure at below 0° C. and in the presence of a catalyst.

1,436,289, Nov. 21, 1922, H. Plauson.

Treats coal, etc., with SO₂ in acetone solution.

1,438,101, Dec. 5, 1922, R. E. Divine.

Precipitation of aluminum sulfonic acid compound. Sulfonic acid is then freed by use of H₂SO₄.

1,438,123, Dec. 5, 1922, K. P. McElroy.

Passes unsaturated hydrocarbons through a hot dilute acid at a temperature sufficient to volatilize the alcohols formed.

1,438,710, Dec. 12, 1922, S. P. Miller (to The Barrett Co.).

Purifies naphthalene by passing its vapors through H₂SO₄.

1,438,764, Dec. 12, 1922, E. M. Johansen, (to The Atlantic Refining Co.).

Treats mineral oil in succession with soap solution, acid, and alkali.

1,438,985, Dec. 19, 1922, T. G. Delbridge (to The Atlantic Refining Co.).

Washes paraffin oil mixture with soap solution.

1,439,171, Dec. 19, 1922, C. F. Kennedy (to The Atlantic Refining Co.).

Separates paraffin by washing with soap solution, chilling, and settling.

1,440,286, Dec. 26, 1922, G. F. Forwood (to The United Kingdom Oil Co., Ltd.).

Passes atomized oil and steam through porous charcoal heated to 500°-600° C.

1,441,417, Jan. 9, 1923, D. F. Gould (to The Barrett Co.).

Treats molten naphthalene with H₂SO₄.

1,445,688, Feb. 20, 1923, E. M. Hyatt (½ to H. B. Taylor).

Treats fuel oil with Cl₂ before cracking.

1,448,084, Mar. 13, 1923, T. F. Ott.

Treats lubricating oil in successive stages with H₂SO₄.

1,448,688, Mar. 13, 1923, D. F. Gould (to The Barrett Co.).

Prepares crystals of naphthalene by agitating molten naphthalene with aqueous solution of NaCl and crystallizing.

1,449,734, Mar. 27, 1923, U. F. Clemons (½ to C. F. O'Neal).

Places body of fullers earth or the like in the vapor space of an oil still.

1,450,493, Apr. 3, 1923, C. Ellis and A. A. Wells (to S. B. Hunt, trustee).

Cracked hydrocarbons are dissolved in H₂SO₄. This acid is diluted and distilled to obtain alcohols. The alcohols can be oxidized to form ketones.

1,450,617, Apr. 3, 1923, J. Smith.

Desulfurizes mineral oil by digestion under pressure with cotton waste saturated with alkali.

1,451,052, Apr. 10, 1923, H. Rostin.

Passes oil vapors and H₂S over heated Cu to effect hydrogenation.

1,454,593, May 8, 1923, E. E. Arnold (to The Nitrogen Corp.).

Treats mineral oil with anhydrous NH₃ in the presence of a catalyst and an alkali metal oxygen-bearing compound to desulfurize.

1,454,617, May 8, 1923, E. E. Ayres, Jr. (to The Sharples Specialty Co.).

Prevents emulsion formation by adding a colloidal resinate solution to the oil.

1,457,656, June 5, 1923, A. E. Dunstan and F. B. Thole.

Desulfurizes petroleum oils by treatment with silica or like gel.

1,458,646, June 12, 1923, R. Engelhardt, W. Lommel, and A. Ossenbeck (to Farbenfabriken vorm. F. Bayer and Co.).

Absorbs C₂H₄ in H₂SO₄ in the presence of an Ag catalyst.

1,459,328, June 19, 1923, C. N. Forrest, H. P. Hayden, and O. R. Douthett (to The Barber Asphalt Paving Co.).

Treats gases and distillates obtained from gilsonite with H₂SO₄ to obtain sulfonated products.

1,460,718, July 3, 1923, C. H. Hapgood (to The De Laval Separator Co.).

Dehydrates switch oil by treating with soap solution and centrifuging.

1,464,152, Aug. 7, 1923, C. Ellis (to S. B. Hunt, trustee).

Treats vapors from a cracking process with H₂SO₄.

1,464,153, Aug. 7, 1923, C. Ellis (to S. B. Hunt, trustee).

Treats distillation gases with H₂SO₄ to remove olefins.

1,464,851, Aug. 14, 1923, S. P. Miller and J. B. Hill (to The Barrett Co.).

Polymerizes solvent naphtha with H₂SO₄, AlCl₃, etc.

1,471,150, Oct. 16, 1923, K. Dziewoński.
Treats dinaphthylmethiophene with H_2SO_4 to make dye stuff.

1,472,882, Nov. 6, 1923, H. R. Moody.
Heats petroleum distillate with an alkali and a metal from which nascent H is generated.

1,473,734, Nov. 13, 1923, C. F. Paul, Jr. (to E. Nalle, W. P. Allen, and E. Rosen-gren, trustees).
Covers an emulsifier for mixing oil and a treating agent.

1,474,062, Nov. 13, 1923, H. Bollmann.
Covers apparatus for treating oil with clay, etc.

1,474,136, Nov. 13, 1923, F. W. Bayard (to E. I. du Pont de Nemours and Co.).
Treats coal tar distillate with dilute H_2SO_4 to remove unsaturated compounds.

1,474,147, Nov. 13, 1923, J. L. Gray.
Passes distillation vapors from high S crude through molten Pb or its equivalent to produce low S distillate.

1,474,933, Nov. 20, 1923, R. E. Hum-
phreys, F. M. Rogers, and O. E. Bransky (to Standard Oil Co. of Indiana).
Prepares sulfonic acids from petroleum hav-
ing a combining weight of approximately 360.

1,475,259, Nov. 27, 1923, L. duP. Clement (to Kent County Oil Corp.).
Agitates a mixture of toluol, kerosene, $Al_2(SO_4)_3$, $NaHCO_3$, H_2SO_4 , $K_2Cr_2O_7$, and naphtha to prepare motor fuel.

1,477,829, Dec. 18, 1923, E. M. Johansen (to The Atlantic Refining Co.).
Produces sulfo-compounds by subjecting high boiling cracked distillate to the action of a sulfo-nating agent.

1,479,852, Jan. 8, 1924, A. Engelhardt (to Farbinstofffabriken vorm. F. Bayer and Co.).
Reaction of H_2S and O_2 to form H_2O and S is basis of this patent.

1,480,368, Jan. 8, 1924, J. Black.
Distils a mixture of crude petroleum, raw coal oil, acetone, benzol, sal soda, and wood alcohol with steam to prepare a motor fuel.

1,480,372, Jan. 8, 1924, E. A. Charbon-
neaux.
Treats crude oil with HNO_3 .

1,482,804, Feb. 5, 1924, M. D. Mann, Jr. (to S. B. Hunt, trustee).
Prepares isopropyl ether by reacting on iso-
propyl alcohol with H_2SO_4 of less than 85% strength.

1,483,835, Feb. 12, 1924, A. S. Ramage (to Bostaph Engineering Corp.).
Treats olefins mixed with aromatics with H_2SO_4 , separates the treated mixture and acid sludge, and fractionally distils the polymerized products.

1,484,167, Feb. 19, 1924, V. S. Allien (to Darco Corp.).
Uses 1% calcium carbonate on the weight of the carbon to purify "a sour gasoline."

1,485,083, Feb. 26, 1924, M. H. Kotzebue and L. M. Bowman.
Passes cracked vapors through steel wool and solid filtering material.

1,486,646, Mar. 11, 1924, C. Ellis and M. J. Cohen (to S. B. Hunt, trustee).
Treats olefin-containing material with H_2SO_4 of 1.8 sp. gr. under temperature controlled conditions to produce reactive liquor from which alcohols can be made by hydrolysis.

1,486,647, Mar. 11, 1924, C. Ellis and M. J. Cohen, G. Cohen, A. Breslauer, and H. Asher, exrs. (to S. B. Hunt, trustee).
Prepares secondary alcohols by absorbing olefins in H_2SO_4 and hydrolyzing the product.

1,487,240, Mar. 18, 1924, E. C. Higgins, Jr. and O. C. Smith (1/2 to Cosden and Co.).
Treats acid sludge with alkali and live steam and removes the lowermost layer to obtain a homogeneous liquid fuel in the upper layer.

1,492,184, Apr. 29, 1924, J. W. Weir and J. C. Black.
Uses clay to which has been added H_2SO_4 which is claimed to have greater treating effect.

1,492,969, May 6, 1924, A. E. Dunstan.
Treats cracked gasoline with Cl_2 and separates the gasoline from the impurities.

1,494,400, May 20, 1924, A. Zinke and A. Klingler (to Perylene Co., Inc.).
Melts dioxyperylene with S and Na_2SO_3 to form sulfurized perylene.

1,495,074, May 20, 1924, A. F. Hoffman.
Sulfite waste liquors for lubricating cutting tools.

1,495,891, May 27, 1924, R. E. Divine.
Prepares a sulfonic fat-splitting agent de-
rived from petroleum sulfonic sludge compris-
ing Al sulfonates.

1,496,084, June 3, 1924, K. Dziewoński.
Treats dinaphthylmethiophene with H_2SO_4 and HNO_3 to form dyestuffs.

1,504,772, Aug. 12, 1924, F. W. Manning (to Manning Refining Equipment Corp.).
Mixes oil with fullers earth, filters, and washes the filter cake with naphtha.

1,506,115, Aug. 26, 1924, R. N. Donaldson and R. McCollum (to Standard Oil Co. of Calif.).
Removes asphalt from crude oil by treatment with dilute H_2SO_4 .

1,506,228, Aug. 26, 1924, H. Dreyfus.
Prepares dialkyl sulfate by distilling an alkali metal pyrosulfate with a simple aliphatic alcohol.

1,506,385, Aug. 26, 1924, F. H. Rhodes (to The Barrett Co.).
Removes pyridin bases from hydrocarbon oil by treating with an acid and neutralizing with a solution of alkali salts of tar acids.

1,507,692, Sept. 9, 1924, F. H. Smith and G. J. Ziser (to Standard Oil Co. of Calif.).
Ages distillate before treating with decolorizing absorbents.

1,508,625, Sept. 16, 1924, C. W. Stratford.
Heats the clay and oil separately, mixes hot, and filters.

1,510,425, Sept. 30, 1924, W. Traube.
Prepares ethyl esters of halogen sulfonic acid by treating this acid with C_2H_4 .

1,511,721, Oct. 14, 1924, W. N. Davis and G. A. Davidson (to Standard Oil Co. of Calif.).
Hydrolyzes sulfonated oils and sludge acids with steam in an insulated container.

1,513,133, Oct. 28, 1924, A. J. Rowland.
Blows asphalt at 300° F. with air and treats with HCl.

1,515,093, Nov. 11, 1924, V. C. Crites and K. A. Wright (to American Oil Dehydrating Co.).
Dehydrates petroleum oil by treating with hot CaCl_2 solution.

1,515,315, Nov. 11, 1924, A. E. Roberts (to The Barrett Co.).
Polymerizes solvent naphtha with H_2SO_4 , AlCl_3 , etc.

1,515,597, Nov. 18, 1924, P. P. Hindelang (to Standard Fullers Earth Co., Inc.).
Treats oil with a clay mud and filters.

1,515,733, Nov. 18, 1924, R. Cross.
Covers a material consisting of a dried inorganic gel absorbent, impregnated with a metallic salt, for treating oils.

1,516,879, Nov. 25, 1924, F. K. Bezzenger (to R. S. Gehr, trustee).
A cutting oil containing a sulfurized oil and substantially free from H_2S .

1,520,953, Dec. 30, 1924, E. M. Johansen (to The Atlantic Refining Co.).
Separates hydrocarbon mixtures by emulsifying with soap solution and separating the unemulsified hydrocarbons from the mixture.

1,521,278, Dec. 30, 1924, E. M. Clark (to Standard Development Co.).
Treats petroleum distillate with 66° Bé. H_2SO_4 , redistills, and again treats the distillate with 66° Bé. H_2SO_4 .

1,521,282, Dec. 30, 1924, S. H. Diggs (to Standard Oil Co. of Indiana).
Treats oil with H_2SO_4 , removes sludge, and treats with finely dispersed hydrated lime.

1,521,283, Dec. 30, 1924, S. H. Diggs (to Standard Oil Co. of Indiana).
Treats oil with fuming H_2SO_4 before removing the sludge from treatment with ordinary H_2SO_4 .

1,523,053, Jan. 13, 1925, U. F. Clemons.
Packs the vapor of an oil still with fullers earth or the like.

1,524,859, Feb. 3, 1925, C. N. Forrest, H. P. Hayden, and O. R. Douthett (to The Barker Asphalt Co.).
Relates to gilsonite products obtained from gilsonite through sulfonation treatment.

1,525,016, Feb. 3, 1925, J. W. Weir.
Separates acid or other sludge from oil by centrifuging.

1,525,211, Feb. 3, 1925, J. L. Stevens.
Uses a flotation agent the product formed from an alcohol, CS_2 , and alkali.

1,525,301, Feb. 3, 1925, A. Kinsel.
Recover plumbite solution from spent doctor solution by converting PbS into PbSO_4 with H_2SO_4 and converting PbSO_4 into sodium plumbite with NaOH .

1,526,665, Feb. 17, 1925, L. Edeleanu and W. Hess.
Treats hydrocarbon oils with liquid SO_2 in stages.

1,527,836, Feb. 24, 1925, G. J. Burns.
Discloses a still adapted for the distillation of hydrocarbons in the presence of chemical reagents.

1,527,847, Feb. 24, 1925, A. M. Duckham and J. S. Morgan (to Thermal Industrial and Chemical Research Co., Ltd.).
Distils oil in a molten metal bath.

1,528,327, Mar. 3, 1925, J. Hancock, M. C. Hancock, admrx.
Atomizes oil into a spray of steam and injects a chemical into the mixture before heating to cracking temperature.

1,528,398, Mar. 3, 1925, B. T. Brooks and H. O. Parker (to The Mathieson Alkali Works, Inc.).
Desulfurizes cracked gasoline by treatment with hypochlorite solution followed by distillation with AlCl_3 .

1,528,884, Mar. 10, 1925, H. T. Maitland (to Sun Oil Co.).
Prepares linseed oil substitute by dissolving in hydrocarbon solvent soaps of fatty acids prepared from mineral oil, and treating with mineral acid and $\text{Al}_2(\text{SO}_4)_3$.

1,531,173, Mar. 24, 1925, J. D. Brady.
Prevents emulsion formation in oil wells by introducing a water-softening chemical solution into the well.

1,533,325, Apr. 14, 1925, H. T. Maitland (to Sun Oil Co.).
Treats oil with H_2SO_4 and air and centrifuges.

1,534,376, Apr. 21, 1925, H. G. Fowler (to Associated Oil Co.).
Treats lubricating oil with H_2SO_4 and alkali followed by treatment with a decolorizing agent.

1,534,554, Apr. 21, 1925, F. W. Wagner (to Jones and Laughlin Steel Corp.).
Prepares a grease from the residue obtained by treating coal tar derivatives with H_2SO_4 .

1,534,555, Apr. 21, 1925, F. W. Wagner (to Jones and Laughlin Steel Corp.).
Emulsifies residue from the treatment of coal tar distillates, diluted with petroleum oil, and distils to produce a grease.

1,535,653, Apr. 28, 1925, G. Egloff and H. P. Benner (to Universal Oil Products Co.).
Distils in the presence of fullers earth and HCl.

1,536,908, May 5, 1925, J. S. Morgan (to Thermal Industrial and Chemical Research Co., Ltd.).
Distils oil in a molten metal bath.

1,538,287, May 19, 1925, W. Kritchevsky and H. C. Prutsman (to W. Citron, trustee).
Deodorizes kerosene by treating with chlorosulfonic acid, neutralizing, and treating with a solid absorbent colloid.

1,538,650, May 19, 1925, W. Peacock and D. Gray (1/2 to C. M. Woolworth).
Soda lime as absorbent for gases like H_2S , etc.

1,540,218, June 2, 1925, W. T. Maloney.
Prepares transformer oil by oxidizing with ozone and adding alkaline reagent to precipitate oxidized bodies.

1,540,929, June 9, 1925, S. P. Coblenz and S. P. Coleman (to Humble Oil and Refining Co.).
Emulsifies acid treated oil with a salt solution and subjects the mixture to cataphoretic action.

1,541,226, June 9, 1925, H. C. Karns (to The Koppers Co.).
Treats aromatic hydrocarbons with H_2SO_4 and distils to produce coumarone resins.

1,541,274, June 9, 1925, H. F. Perkins.
Passes distillation vapors through metallic packing.

1,545,440, July 7, 1925, H. Neumann.
Treats hydrocarbons with a saturated solution of ferric halide to separate cokevite-like compounds.

1,547,682, July 28, 1925, Re 16,439, Oct. 12, 1926, P. W. Prutzman (to General Petroleum Corp.).
Treats oil with clay, heats above 350° F., and steams before filtering.

1,548,992, Aug. 11, 1925, R. W. Hanna and J. F. Brooks (to Standard Oil Co. of Calif.).
Treats kerosene with H_2SO_4 at 200° F.

1,549,469, Aug. 11, 1925, A. E. Dunstan.
Treats with hypochlorite solution, redistills, and treats with solid absorbent.

1,550,523, Aug. 18, 1925, Egon Eichwald.
Treats with furfural to desulfurize.

1,551,806, Sept. 1, 1925, R. F. Davis (to Standard Oil Co. of Calif.).
Desulfurizes petroleum oils by acid treating and neutralization with alkali and then treats cold with copper oxide in presence of light.

1,551,909, Sept. 1, 1925, P. W. Prutzman (to General Petroleum Corp.).
Covers apparatus for treating oil with clay.

1,552,072, Sept. 1, 1925, F. W. Manning (to Manning Refining Equipment Corp.).
Treats oil with clay and separates by centrifuging.

1,552,830, Sept. 8, 1925, A. E. Dunstan.
Treats hydrocarbons with alkaline hypochlorite solution followed by alkali wash.

1,553,141, Sept. 8, 1925, L. H. Clark (to The Sharples Specialty Co.).
Purifies impure oil containing finely dispersed carbon by making alkaline with $NaOH$ and centrifuging.

1,558,631, Oct. 27, 1925, Herman Reinbold and Hugo Reinbold (Hugo Reinbold as's to Herman Reinbold).
Grinds bentonite and then adds HCl slowly to form $AlCl_3$ in the clay as well as $LiCl$.

1,558,632, Oct. 27, 1925, Herman Reinbold and Hugo Reinbold (Hugo Reinbold as's to Herman Reinbold).
 $AlCl_3$ and another salt as $LiCl$.

1,561,999, Nov. 17, 1925, P. W. Prutzman (to General Petroleum Corp.).
Mixes the clay with the oil in successive steps and finally heats to above 350° F. before filtering.

1,562,000, Nov. 17, 1925, P. W. Prutzman and P. D. Barton (to General Petroleum Corp.).
Removes acid tar from acid-treated oil by agitation with spent clay from a previous contact filtration stage.

1,562,001, Nov. 17, 1925, P. W. Prutzman and C. J. von Bibra (to General Petroleum Corp.).
Treats oil with a clay mud and heats to drive off water before filtering.

1,562,156, Nov. 17, 1925, J. F. Faber, H. C. Hanna, and M. L. Chappell (to Standard Oil Co. of Calif.).
Adds water-soluble salts of carboxylic acid derived from petroleum to acid-treated oil to prevent emulsion formation.

1,563,012, Nov. 24, 1925, B. T. Brooks (to Carbide and Carbon Chemicals Corp.).
Treats cracked distillate with H_2SO_4 , neutralizes, and redistills.

1,564,501, Dec. 8, 1925, J. W. Weir (1/2 to J. C. Black).
Heats acid-treated lubricating oil with clay and blows with a non-oxidizing gas.

1,568,606, Jan. 5, 1926, A. B. Hutton.
Compound for grease containing S.

1,568,812, **1,568,813**, Jan. 5, 1926, W. F. Downs, M. G. Downs, admrx.
Purifies hydrocarbon liquids by passage through heated $AlCl_3$.

1,568,886, Jan. 5, 1926, A. M. Duckham and J. S. Morgan (to Thermal Industrial and Chemical Research Co., Ltd.).
Distils oil in contact with molten metal.

1,568,904, Jan. 5, 1926, J. C. Morrell (to Universal Oil Products Co.).
Treats with H_2SO_4 , saturates with SO_2 , and then treats with doctor solution.

1,569,855, Jan. 19, 1926, G. Egloff and H. P. Benner (to Universal Oil Products Co.).
Passes cracked vapors through a filter bed to desulfurize.

1,569,870, Jan. 19, 1926, J. C. Morrell (to Universal Oil Products Co.).
Treats with doctor solution followed by sulfide solution.

1,569,871, Jan. 19, 1926, J. C. Morrell (to Universal Oil Products Co.).
Treats in succession with doctor solution, sulfide solution, and a flocculating agent.

1,569,872, Jan. 19, 1926, J. C. Morrell (to Universal Oil Products Co.).
Treats with doctor solution and then with aqueous sulfide solution.

1,570,005, Jan. 19, 1926, Herman Reinbold and Hugo Reinbold (Hugo Reinbold as's to Herman Reinbold).
Bleaches, cracks, and desulfurizes petroleum by use of $AlCl_3$ in colloidal state.

1,570,193, Jan. 19, 1926, G. W. Acheson.
Desulfurizes bituminous and crude oils by treatment with "reflocculated" solid absorbents.

1,570,584, Jan. 19, 1926, C. Ellis (to Ellis-Foster Co.).
Desulfurizes polymerized resins by washing with alkali.

1,570,890, Jan. 26, 1926, F. W. Hall (to The Texas Co.).
Filters oil upwardly through a mass of clay.

1,572,465, Feb. 9, 1926, J. C. Black and J. W. Weir.
Heats acid-treated oil with clay to 180° F. before filtering.

1,573,370, Feb. 16, 1926, E. Blümner.
Distils oil in a molten metal bath.

1,574,507, Feb. 23, 1926, G. G. Oberfell, A. M. Ballard, R. C. Alden, E. L. Utsinger, and W. R. Lentz (to Chestnut and Smith Corp.).

Dissolves S in natural gas gasoline and then passes it through warmed doctor solution.

1,574,742, Mar. 2, 1926, G. W. Acheson. Treats oil with "reflocculated" solid absorbent material.

1,574,796, Mar. 2, 1926, A. A. L. J. Damiens, M. C. J. E. de Loisy, and O. J. G. Piette.

Uses CuSO_4 as a catalyst in the absorption of C_2H_4 in H_2SO_4 .

1,578,235, Mar. 23, 1926, C. N. Forrest, H. P. Hayden, and O. R. Douthett (to The Barker Asphalt Co.).

Relates to gilsonitic products obtained from gilsonite through sulfonation treatment.

1,580,531, Apr. 13, 1926, J. B. Rather (to Standard Oil Co. of N. Y.).

Treats oil with H_2S gas before the doctor treatment.

1,581,369, Apr. 20, 1926, J. W. Weir.

Treats with H_2SO_4 settles, and removes sludge; treats with absorbent material at temperature to decompose sludge present, then adds litharge.

1,581,370, Apr. 20, 1926, J. W. Weir.

Treats lubricating oil with acid and then the neutralized stock with clay by contact filtration.

1,585,473, May 18, 1926, L. Edeleanu.

Extracts petroleum distillates with liquid SO_2 and adds the extract to motor fuel.

1,585,922, May 25, 1926, A. Jurrissen (to Simplex Refining Co.).

Treats lubricating oils mixed with H_2SO_4 with clay, adds alkali to neutralize, and filters.

1,587,491, June 1, 1926, R. Cross.

Passes distillation vapors through a mixture of bentonite, diatomaceous earth and Cu salt.

1,587,649, June 8, 1926, E. M. Johansen (to The Atlantic Refining Co.).

Blends oils containing respectively sour and corrosive S and treats with doctor solution.

1,589,372, June 22, 1926, A. A. L. J. Damiens, M. C. J. E. de Loisy, and O. J. G. Piette.

Uses CuSO_4 as a catalyst in the absorption of C_2H_4 in H_2SO_4 .

1,589,390, June 22, 1926, H. Herminghaus (to Winthrop Chemical Co., Inc.).

Sulfonation of thioanthrenes.

1,590,800, June 29, 1926, A. E. Becker (to Standard Development Co.).

Prepares lubricant by heating an oil or fat with S.

1,592,058, July 13, 1926, J. W. Weir.

Treats lubricating oil with acid and solid absorbent.

1,592,329, July 13, 1926, Re 16,679, July 12, 1927—Reissue only assigned to Pan American Petroleum Co., J. C. Black, W. D. Rial, and R. T. Howes.

Treats cracked gasoline with weak alkaline solution, then strong alkaline solution under pressure and redistills.

1,592,543, July 13, 1926, J. K. Stewart (to Shell Co. of Calif.).

Decolorizing, purifying and absorbent mass comprising substantially only Al_2O_3 and SiO_2 in activated condition.

1,594,041, July 27, 1926, H. J. Broderson and W. E. Bartels (to Standard Oil Co. of Indiana).

Covers a mixer for treating oil with acid, etc.

1,594,083, July 27, 1926, G. L. Wendt (to Standard Oil Co. of Indiana).

Treats with doctor solution and distills.

1,594,823, Aug. 3, 1926, C. Ellis (to S. B. Hunt, trustee).

Passes natural gas under sub-atmospheric pressure through a heated cone, absorbs the resulting gas in H_2SO_4 and hydrolyzes to produce alcohols.

1,598,560, Aug. 31, 1926, J. N. Compton (to Carbide and Carbon Chemicals Corp.).

Absorbs C_2H_4 in a bath of specified concentrations of C_2H_4 and SO_3 .

1,599,119, Sept. 7, 1926, A. A. L. J. Damiens, M. C. J. E. de Loisy, and O. J. G. Piette.

Uses CuSO_4 as a catalyst in the absorption of C_2H_4 in H_2SO_4 .

1,599,429, Sept. 14, 1926, A. Oberle (1/2 to T. E. Scofield).

Passes distillation vapors through active carbon.

1,600,525, Sept. 21, 1926, A. Thauss (by mesne to Grasselli Dyestuff Corp.).

Preparation of thiophenol sulfonic acid.

1,600,845, Sept. 21, 1926, H. Reinbold.

Desulfurizes with bentonite first mixed with NaOH , then treats with Cl_2 .

1,601,215, **1,601,216**, Sept. 28, 1926, E. Johansen (to New England Oil Refining Co.).

Treats sour distillate with lead oxide or plumbate to prepare motor fuel.

1,601,406, Sept. 28, 1926, H. R. Moody.

Hydrogenates unsaturated organic bodies by treatment with Al_2C_3 and AlCl_3 at elevated temperature.

1,601,753, Oct. 5, 1926, T. Hellthaler (to Hugo Stinnes Riebeck Montan und Ölwerke A. G.).

Treats mineral oil with Sb pentahalides.

1,602,703, Oct. 12, 1926, R. C. Pollock (to Union Oil Co.).

Treats gasoline with acid and clay.

1,603,174, Oct. 12, 1926, J. W. Weir.

Treats lubricating stock containing some sludge from a previous acid treatment with clay, and heats before filtering.

1,603,314, Oct. 19, 1926, L. Caldwell (to The Celite Co.).

Treats oil with lime-treated diatomaceous earth and washes with water.

1,603,701, Oct. 19, 1926, P. McMichael (to Hydrocarbon Refining Process Co., Inc.).

Treats in succession with alkali, dilute acid, and distills over fixed alkali.

1,604,068, Oct. 19, 1926, W. H. Oldacre (to D. A. Stuart and Co.).
Cutting fluid containing S in colloidal suspension or in loose chemical combination with the oils.

1,604,235, Oct. 26, 1925, L. L. Odom (to M-O-R Products Co.).
Removes more than 99 3/4% of the S in oil vapors by passage through copper wool.

1,604,641, Oct. 26, 1926, R. A. Halloran, W. N. Davis, G. A. Davidson (to Standard Oil Co. of Calif.).
Hydrolyzes sludge acids to separate tar and acid.

1,605,046, Nov. 2, 1926, H. T. Maitland (to Sun Oil Co.).
Treats distillate with alkali, steam, acid, alkali, steam, and fullers earth, in succession.

1,608,089, Nov. 23, 1926, G. Egloff and H. P. Benner (to Universal Oil Products Co.).
Distils in the presence of fullers earth and NaOH.

1,608,135, Nov. 23, 1926, J. C. Morrell (to Universal Oil Products Co.).
Distils petroleum oil in the presence of an absorbing agent and extracts resins from the absorbent.

1,608,328, Nov. 23, 1926, A. M. McAfee (to Gulf Refining Co.).
Heats petroleum oil with H₂ in presence of AlCl₃.

1,608,329, Nov. 23, 1926, A. M. McAfee (to Gulf Refining Co.).
Heats cracked gasoline with AlCl₃ or Al and Cl or HCl.

1,608,339, Nov. 23, 1926, H. M. Ridge and W. R. Hodgkinson.
Desulfurizes oil by treatment with a mixture of Cu, CuO, and Cu halide.

1,609,349, Dec. 7, 1926, F. I. DuPont (to Delaware Chemical Engineering Co.).
Distils oil over circulating molten metal.

1,615,286, Jan. 25, 1927, O. D. Lucas and E. L. Lomax (to V. L. Oil Processes, Ltd.).
Passes vapors from acid- and alkali-treated oil through a filter containing bauxite, floridin, or the like.

1,616,352, Feb. 1, 1927, E. B. Cobb (to Standard Development Co.).
Destroys emulsion-forming compounds present in acid-treated oils by heating.

1,616,353, Feb. 1, 1927, E. B. Cobb (to Standard Development Co.).
Refines heavy distillates by treating with fuming H₂SO₄, distilling, and treating the distillate with fuming acid.

1,617,201, Feb. 8, 1927, H. N. Dons (to N. A. Hallauer, trustee).
Breaks emulsions by treating with cellulose impregnated with alkali.

1,619,074, Mar. 1, 1927, H. L. Johnson (to Standard Development Co.).
Lubricants containing sulfonic acids.

1,621,475, Mar. 15, 1927, W. M. Cross.
Limits time of contact between the oil and acid to about 30 seconds.

1,622,671, Mar. 29, 1927, J. B. Rather and F. S. Shepard (to Standard Oil Co. of N. Y.).
Removes high S oil from metallic sulfides.

1,622,879, Mar. 29, 1927, H. O. Parker (to the Mathieson Alkali Works).
Treats hydrocarbon oils with hypochlorite solution and free Cl₂.

1,623,018, Mar. 29, 1927, R. Cross.
Desulfurizes petroleum distillates by treatment with Cl₂ in presence of sunlight.

1,624,692, Apr. 12, 1927, H. Thomas (to Sun Oil Co.).
Filters cracked gasoline through solid decolorizing material to produce a decolorized product.

1,625,195, Apr. 19, 1927, S. J. Dickey (to General Petroleum Corp.).
Passes acid countercurrent to the oil in a continuous treating process by means of injectors.

1,625,415, Apr. 19, 1927, L. Lilienfeld.
Treats solvent naphtha with H₂SO₄ before vacuum distilling to produce high boiling point, oily bodies.

1,627,054, May 3, 1927, J. C. Morrell and G. Egloff (to Universal Oil Products Co.).
Prepares resins by extracting with a solvent solid absorbent with which petroleum oil has been heated.

1,627,055, May 3, 1927, J. C. Morrell and S. Comay (to Universal Oil Products Co.).
Treats hydrocarbon oil with Cu(OCl)₂ solution.

1,627,338, May 3, 1927, H. O. Parker (to The Mathieson Alkali Works).
Treats petroleum distillates with hypochlorite solution.

1,628,423, May 10, 1927, M. G. Paulus (to Standard Oil Co. of Indiana).
Passes still gases containing H₂S through oil to be sweetened before treating with doctor solution.

1,628,747, May 17, 1927, O. J. Salisbury.
Treats oil with clay in a series of agitators in one of which partially spent material is used.

1,631,401, June 7, 1927, R. Cross (to Gasoline Products Co., Inc.).
Treats petroleum oil with SO₂ and cracks the treated oil.

1,635,718, July 12, 1927, C. Leaver (to Imperial Oil, Ltd.).
Treats oil with acid in a baffled mixer.

1,635,896, July 12, 1927, J. S. Morgan and D. Rider (to Thermal Industrial and Chemical Research Co., Ltd.).
Distils tar in molten metal.

1,636,938, July 26, 1927, H. L. Kauffman and I. A. Clark (to Kauffman).
Treats oil with a clay mud, beats, and filters.

1,636,946, July 26, 1927, F. W. Weber.
Treats crude oil in a series of steps with filtration, Ca(OCl)₂, Na₂O₂, H₂SO₄, colloidal FeCl₃ liquor containing basic chlorides of rare metals, Na silicate solution, and distillation.

1,638,643, Aug. 9, 1927, H. Schlossstein.
Hypochlorite treatment using Al and Mg.

1,638,644, Aug. 9, 1927, H. Schlosstein.
Hypochlorite method of treating.

1,639,531, Aug. 16, 1927, E. B. Phillips and J. G. Stafford (to Sinclair Refining Co.).
Scrubs distillation vapors with alkali solution.

1,639,988, Aug. 23, 1927, S. J. Dickey and R. C. Wheeler (to General Petroleum Corp.).
Passes acid-treated oil from which the sludge has been separated, through a sand pack.

1,640,720, Aug. 30, 1927, L. W. Parsons and S. P. Coleman (to Standard Development Co.).
Adds 1% to 10% of CuO and heats with agitation to 120° to 350° F. for 15 to 30 min. and then introduces the oil into a still containing 2% to 8% NaOH and distils.

1,641,005, Aug. 30, 1927, R. H. McKee.
Prepares alkyl sulfates by treating alcohols with SO_2Cl_2 .

1,641,546, Sept. 6, 1927, P. McMichael (to The Hydrocarbon Refining Process Co., Inc.).
Treats oil with SO_2 gas, and then with clay, etc.

1,643,272, Sept. 20, 1927, T. Hellthaler (to Hugo Stinnes Riebeck Montan und Ölwerke A. G.).
Treats mineral oil with titanium tetrahalide diluted by inert substances.

1,645,530, Oct. 18, 1927, T. Hellthaler (to Hugo Stinnes Riebeck Montan und Ölwerke A. G.).
Treats oil with tin tetrahalide precipitated upon solid, finely distributed carriers.

1,645,679, Oct. 18, 1927, F. C. Axtell (to Axtell Research Laboratories, Inc.).
Desulfurizes mineral oils by treating with a mixture of H_2SO_4 and an aromatic hydrocarbon saturated with fuming H_2SO_4 .

1,647,459, Nov. 1, 1927, E. B. Miller (to The Silica Gel Corp.).
Obtains "sweet" to doctor test by exposing to actinic rays and then treating with a porous absorbing material.

1,649,384, Nov. 15, 1927, H. Blumenberg, Jr.
Treats cracked gasoline with Al chloro sulfate.

1,650,782, Nov. 29, 1927, J. W. Weir and W. J. Ryan, Jr.
Removes soaps formed by neutralizing acid-treated lubricating oil by adding alkali and a solid absorbent, and filtering.

1,651,328, Nov. 29, 1927, L. Edeleanu, K. Pfeiffer, K. Gress, and P. Jodeck.
Covers apparatus for treating oils with liquid SO_2 .

1,653,735, Dec. 27, 1927, P. W. Prutzman (to Contact Filtration Co.).
Heats oil-clay mixtures in the decolorizing of the oil by treatment with clay.

1,654,581, Jan. 3, 1928, R. Cross.
Treats in counter-current flow with doctor solution at 200° F., or above, and under pressure.

1,655,068, Jan. 3, 1928, P. McMichael (to Hydrocarbon Refining Process Co., Inc.).
Treats petroleum with fixed alkali followed by acid treatment.

1,655,069, Jan. 3, 1928, P. McMichael (to Hydrocarbon Refining Co., Inc.).
Treats petroleum oils with fixed alkali and FeSO_4 in the presence of air followed by treatment with 70% to 83% H_2SO_4 .

1,655,175, Jan. 3, 1928, V. C. Benjamin.
Covers a method of separating clay, etc., from oil in which it is admixed.

1,655,890, Jan. 10, 1928, A. F. L. Bell (to Associated Oil Co.).
Covers apparatus for treating oil with clay, etc.

1,656,990, Jan. 24, 1928, A. Schwarz (to Petroleum Sand Products Corp.).
Treats distillates with H_2SO_4 in solution with another distillate.

1,656,997, Jan. 24, 1928, J. C. Black.
Treats oil by contact filtration with acid-treated clay.

1,657,522, Jan. 31, 1928, M. L. Weiss (to Dovan Chemical Corp.).
Pentathiphene derivatives.

1,658,171, Feb. 7, 1928, P. McMichael (to Hydrocarbon Refining Process Co., Inc.).
Treats cracked petroleum oils with an aqueous solution of Na_2CrO_4 and NaOH followed by treatment with H_2SO_4 .

1,658,285, Feb. 7, 1928, K. Cox and P. J. McDermott (to Refiners, Ltd.).
Distills benzol, petrol, etc., with $\text{Fe}_2(\text{SO}_4)_3$, and treats the distillate with alkali.

1,658,505, Feb. 7, 1928, G. L. Wendt (to Standard Oil Co. of Indiana).
Treats hydrocarbon oils with alc. doctor solution.

1,659,782, Feb. 21, 1928, R. C. Moran (to Vacuum Oil Co.).
Treats lubricating oil with fuming H_2SO_4 and then with ethylene glycol.

1,660,295, Feb. 21, 1928, R. T. Goodwin (to Standard Oil Development Co.).
Treats residuum with H_2SO_4 to precipitate carbon, etc.

1,661,566, Mar. 6, 1928, L. Edeleanu (to Allgemeine Gesellschaft für Chemische Industrie).
Prepares motor fuel by blending light distillates with heavier distillates treated with liquid SO_2 .

1,664,376, Mar. 27, 1928, D. H. Rowland (to American Ichthyol Oil Co.).
Prepares ammonium ichthyol sulfonate which comprises sulfonating petroleum, etc.

1,665,110, Apr. 3, 1928, G. F. Olsen (to General Petroleum Corp.).
Neutralizes with finely divided solid alkali after the acid treatment.

1,665,111, Apr. 3, 1928, G. F. Olsen (to General Petroleum Corp.).
Dilutes viscous petroleum oils with lighter distillates and treats with liquid SO_2 .

1,666,560, Apr. 17, 1928, L. Edeleanu, K. Pfeiffer, K. Gress, and P. Jodeck.
Covers modifications of the Edeleanu SO_2 process—manner of mixing, etc..

1,666,976, Apr. 24, 1928, J. B. Neuendorff. Treats gasoline, etc., with clear lime-water.

1,667,984, May 1, 1928, P. W. Prutzman (to Contact Filtration Co.). Heats a flowing stream of oil with clay or the like.

1,668,225, May 1, 1928, G. L. Wendt (to Standard Oil Co. of Indiana). Sweetens by adding lower mercaptans before the doctor treatment.

1,668,275, May 1, 1928, W. Hess. Treats hydrocarbons first with gaseous SO_2 and then with liquid SO_2 .

1,668,313, May 1, 1928, F. W. Hall (to The Texas Co.). Prepares lubricating oil by treating with H_2SO_4 and diluting with lighter oil before neutralizing.

1,668,920, May 8, 1928, H. T. Maitland (to Sun Oil Co.). Treats oil with solid absorbent impregnated with H_2SO_4 .

1,669,181, May 8, 1928, C. A. Walter and F. B. Muhlenberg. Agitates gasoline with NH_4Cl , and then CuSO_4 and ZnSO_4 , and decants the settled oil for use as motor fuel.

1,669,944, May 15, 1928, P. McMichael (to Hydrocarbon Refining Process Co., Inc.). Treats petroleum oils with alkaline hyposulfite solution followed by treatment with an alkaline aqueous solution containing a heavy metal compound.

1,672,304, June 5, 1928, M. L. Chappell, G. J. Ziser and E. L. Moyer (to Standard Oil Co. of Calif.). Treats viscous petroleum with H_2SO_4 , neutralizes with alc. caustic, and washes with alcohol.

1,672,621, June 5, 1928, J. R. Neller and G. M. Vance (to The Texas Co.). Treats oil with acid and alkali followed by alc. alkali treatment.

1,673,045, June 12, 1928, E. D. Gray (by mesne to Standard Oil Co. of Calif.). Produces a demulsifying agent from petroleum sulfonate sludge.

1,674,020, June 19, 1928, A. Oberle (½ to T. E. Scofield). Treats petroleum oil with KI solution and then filters.

1,674,676, June 26, 1928, W. Hess (to Allgemeine Gesellschaft für Chemische Industrie). Treats hydrocarbon oils with liquid SO_2 in two stages.

1,676,724, July 10, 1928, A. E. Becker (to Standard Oil Development Co.). Passes distillation vapors through steel wool.

1,677,389, July 17, 1928, R. T. Howes (to Pan American Petroleum Co.). Cylinder oil composition containing "turkey red oil."

1,677,425, July 17, 1928, F. C. Axtell (to Axtell Research Laboratories, Inc.). Treats petroleum oil with H_2SO_4 solutions of persulfuric acid and Caro's acid.

1,677,440, July 17, 1928, W. W. Gary (½ to C. O. Middleton). Passes SO_2 through petroleum at above 140° F.

1,677,731, July 17, 1928, C. Sautermeister and F. Wilhelm. Evaporates sludge acid to 130°C., adds S to the tar to form H_2S which reduces the H_2SO_4 . Forms resins.

1,678,298, July 24, 1928, W. A. Patrick and E. B. Miller (to The Silica Gel Corp.). Treats oil in continuous cyclic process with silica gel or the like.

1,678,299, June 24, 1928, E. B. Miller (to The Silica Gel Corp.). Covers apparatus for effecting cyclic treatment of oil, etc., with solid absorbents such as silica gel.

1,678,311, 1,678,312, July 24, 1928, G. L. Adams (to Standard Oil Development Co.). Uses residuum from the hydrolysis of sulfated olefins with other oils in flotation of ores.

1,678,984, July 31, 1928, R. L. Hallett (to National Lead Co.). Dissolves PbCl_2 in NaOH and treats petroleum products with the resulting solution.

1,679,093, July 31, 1928, S. P. Miller and J. B. Hill (to The Barrett Co.). Polymerizes solvent naphtha with H_2SO_4 in an emulsifier.

1,679,214, July 31, 1928, W. R. Gerges (to The Barrett Co.). Polymerizes solvent naphtha with H_2SO_4 .

1,681,638, Aug. 21, 1928, H. J. Halle (to Universal Oil Products Co.). Passes oil vapors through a column of heated H_2SO_4 and neutralizes the condensate.

1,681,895, Aug. 21, 1928, L. Burgess (to Standard Oil Development Co.). Treats petroleum oil with fuming acid and then after separation of the sludge with NaOH and a monohydric alcohol.

1,682,603, Aug. 28, 1928, T. G. Delbridge and J. B. Hill (to The Atlantic Refining Co.). Treats distillates with fullers earth under elevated temperature and pressure.

1,683,288, Sept. 4, 1928, F. W. Eley (to Anglo-California Trust Co.). Treats mineral oil with HAc in ether.

1,684,035, Sept. 11, 1928, H. L. Kauffman and I. A. Clark (to H. L. Kauffman). Decolorizes petroleum distillates by contact filtration with clay admixed with ZnCl_2 .

1,684,159, Sept. 11, 1928, S. Tijmstra (to Roxana Petroleum Corp.). Treats with doctor and alkali polysulfide solutions.

1,684,489, Sept. 18, 1928, R. A. Halloran (to Standard Oil of Calif.). Discloses a continuous process for treating oil with chemical reagents.

1,684,868, Sept. 18, 1928, I. H. Jones (to The Koppers Co.). Polymerizes solvent naphtha with concentrated H_2SO_4 .

1,685,034, Sept. 18, 1928, D. Rider (to Thermal Industrial and Chemical Research Co., Ltd.).

Passes tars and oils to be distilled through molten metal.

1,686,491, Oct. 2, 1928, W. S. Hughes and J. Harrop (to Standard Oil Development Co.).

Adds water to residue from the distillation of oil with alkali, breaks the resulting emulsion with acid, and removes the aqueous layer to recover inorganic compounds.

1,686,493, Oct. 2, 1928, W. K. Lewis (to Standard Oil Development Co.).

Treats oil with clay in continuous process by providing alternative agitators in which the spent clay can be regenerated.

1,687,992, Oct. 16, 1928, E. B. Phillips and J. G. Stafford (to The Gray Processes Corp.).

Passes oil vapors through solid CuCl_2 and then through fullers earth.

1,688,861, Oct. 23, 1928, G. Egloff (to Universal Oil Products Co.).

Treats cracked residuum with liquid SO_2 and treats the layers which separate with acid or alkali to prepare lubricating oils.

1,689,011, Oct. 23, 1928, M. P. Davis (to Otis Elevator Co.).

Prepares cutting oil by adding finely divided S to hot lard oil.

1,690,772, Nov. 6, 1928, T. G. Delbridge and H. F. Dure (to The Atlantic Refining Co.).

Treats oil with acid, separates the sludge and then treats with clay without previous neutralization.

1,691,266, Nov. 13, 1928, L. Caldwell (to The Celite Co.).

Treats oil with a compound prepared by reacting diatomaceous earth with an alkaline earth hydroxide and chlorinating the product.

1,692,756, Nov. 20, 1928, R. C. Moran (to Vacuum Oil Co.).

Treats oil with metallic Hg and removes S from the Hg with alkali sulfide.

1,695,198, Dec. 11, 1928, D. R. Merrill (to Union Oil Co.).

Treats lubricating oil with clay and oxalic acid.

1,695,251, Dec. 11, 1928, V. A. Kalichevsky (to Union Oil Co.).

Treats light distillates with a light caustic wash followed by acid and clay treatment.

1,696,377, Dec. 25, 1928, J. C. Black and W. H. Low (to Pan American Petroleum Co.).

Sweetens hydrocarbon oils by treatment with $\text{Cd}(\text{OH})_2$.

1,698,076, Jan. 8, 1929, G. H. Taber, Jr. (to Sinclair Refining Co.).

Treats lubricating oil vapors with caustic alkali solution.

1,698,428, Jan. 8, 1929, H. J. Broderson (to Standard Oil Co. of Indiana).

Uses a special mixing device for treating oil with chemical reagents such as acid or alkali.

1,698,432, Jan. 8, 1929, C. L. Erickson (to Standard Oil Co. of Indiana).

Covers an orifice mixer for mixing oil and acid or similar chemical treating agent.

1,698,452, Jan. 8, 1929, F. M. Rogers (to Standard Oil Co. of Indiana).

Dilutes residue from distillation of asphalt base crude with lower viscosity oil, and treats with H_2SO_4 .

1,698,471, Jan. 8, 1929, O. E. Brausky and F. M. Rogers (to Standard Oil Co. of Indiana).

Dilutes with gasoline crude oil residue resulting from distillation of asphalt base crude, and treats with H_2SO_4 .

1,699,989, Jan. 22, 1929, D. Pyzel (to Simplex Refining Co.).

Distils oil in the presence of inert porous material with introduction of steam and oxygen sufficient to support incomplete combustion.

1,700,479, Jan. 29, 1929, F. W. Hall (to The Texas Co.).

Decolorizes lubricating oils by treatment with clay and filtering.

1,702,313, Feb. 19, 1929, A. S. Ramage (to Gyro Process Co.).

Refines mineral oil by treating with acid and alkali.

1,703,158, Feb. 26, 1929, J. M. McClave (to The Conservo Co.).

Distils in the presence of MnO_2 and HCl .

1,703,615, Feb. 26, 1929, O. Dieckmann.

Treats topped residuum with strong H_2SO_4 , washes the sludge with light oil, recirculates the light oil, neutralizes the acid oil, and fractionates.

1,703,616, Feb. 26, 1929, G. Egloff (to Universal Oil Products Co.).

Mixes cracked distillates with drying oil and distils to desulfurize.

1,703,838, Feb. 26, 1929, C. Fischer, Jr. and W. T. Reddish (to The Twitchell Process Co.).

Prepares pure mineral oil sulfonates.

1,704,194, Mar. 5, 1929, E. W. Hultman ($\frac{1}{4}$ to F. P. Duncklee, $\frac{1}{4}$ to J. Monteleone, and $\frac{1}{4}$ to W. R. Simons).

Prepares rubber-like material by the catalytic polymerization and reduction of Dubbs residuum which may contain S.

1,704,206, Mar. 5, 1929, G. F. Olsen (to General Petroleum Corp.).

Treats lubricating oil with H_2SO_4 in a special mixing device.

1,704,246, Mar. 5, 1929, R. A. Halloran (to Universal Oil Products Co.).

Treats pressure distillate with countercurrent flow of water under pressure to remove H_2S .

1,705,199, Mar. 12, 1929, J. C. Morrell (to Universal Oil Products Co.).

Treats cracked residuum with H_2SO_4 to precipitate out the pitch, etc.

1,705,809, Mar. 19, 1929, W. N. Davis, W. H. Hampton, and E. N. Klemgard (to Standard Oil of Calif.).

Treats petroleum oils with H_2SO_4 at below 20°-38° F.

1,705,857, Mar. 19, 1929, R. L. Emery (to Neville Chemical Co.).

Polymerizes solvent naphtha with H_2SO_4 , SnCl_4 , anhydrous H_3PO_4 , etc.

1,706,614, Mar. 26, 1929, L. M. Johnston and J. L. Farrell.
Drops pellets made from a paste of bentonite or the like through oil vapors and passes the vapors up through the accumulation of dry pellets so formed.

1,706,940, Mar. 26, 1929, P. I. Schestakoff.
Manufactures petroleum sulfonic acids and salts thereof.

1,707,187, Mar. 26, 1929, E. B. Cobb and A. Holmes (to Standard Oil Development Co.).
Prepares white petrolatum by treating hydrocarbons containing petrolatum with fuming H_2SO_4 and extracting the sludge with isopropyl alcohol.

1,707,506, Apr. 2, 1929, H. E. Buc (to Standard Oil Development Co.).
Process for manufacturing oil-soluble sulfonates from petroleum oil.

1,708,103, Apr. 9, 1929, K. Marx, K. Brodersen, and K. Bittner (to I. G. Farbenindustrie A.G.).
Sulfonates brown-coal tar oil to form an agent for emulsifying, purifying, wetting, and like uses.

1,708,590, Apr. 9, 1929, J. N. Reeson and W. L. Moss.
Forms a solution for purifying gas containing H_2S and other impurities by combining a base, an Fe salt, and citric acid.

1,708,592, Apr. 9, 1929, W. D. Rial and W. R. Barratt (to Pan American Petroleum Co.).
Treats lubricating oil with $Ca(OH)_2$ and coal tar pitch to add fluorescence thereto.

1,709,149, Apr. 16, 1929, E. B. Phillips and J. G. Stafford (to Sinclair Refining Co.).
Treats oil with H_2SO_4 in a mixer provided with rotating discs.

1,709,203, Apr. 16, 1929, J. C. Black, W. D. Rial, and R. T. Howes (to Pan American Petroleum Co.).
Treats lubricating oils with alkali and solid absorbents.

1,709,315, Apr. 16, 1929, A. Lachman (to Richfield Oil Co.).
Passes distillation vapors through H_3PO_4 and treats the condensate with alkaline solution of hypochlorite.

1,710,063, Apr. 23, 1929, J. C. Morrell (to Universal Oil Products Co.).
Treats with doctor solution, distills and redistills.

1,710,143, Apr. 23, 1929, J. C. Black and M. L. Chappell (to Pan American Petroleum Co.).
Treats hydrocarbon oils at below 32° F. with liquid SO_2 and then with fuming H_2SO_4 in the presence of the SO_2 .

1,710,200, Apr. 23, 1929, J. C. Black and M. L. Chappell (to Pan American Petroleum Co.).
Treats hydrocarbon oils with H_2SO_4 in the presence of liquid SO_2 .

1,710,201, Apr. 23, 1929, J. C. Black and M. L. Chappell (to Pan American Petroleum Co.).
Treats petroleum distillate in counter-flow contact with liquid SO_2 .

1,710,764, Apr. 30, 1929, S. Caplan (to Combustion Utilities Corp.).
Decolorizes tar-acid bearing oils by agitation with weak alkali solution.

1,712,619, May 14, 1929, H. K. Ihrig (to Associated Oil Co.).
Treats oil vapors with a heated mixture of hydrated lime and Fe_2O_3 .

1,712,960, May 14, 1929, A. Lachman (to Richfield Oil Co.).
Treats oil with H_2SO_4 , neutralizes and then treats with H_3PO_4 , and neutralizes.

1,713,346, May 14, 1929, S. R. Merley (to Doherty Research Co.).
Removes polymers from alcohol-acid mixtures by diluting with water and absorbing the polymers with paraffin oil boiling above 400° F.

1,715,095, May, 28, 1929, J. C. Morrell and H. P. Benner (to Universal Oil Products Co.).
Introduces ammonia solution into distillation vapors to prevent corrosion of the apparatus.

1,716,103, June 4, 1929, H. Blumenberg, Jr.
Treats mineral oil with $Al_2(SO_4)_3$ solution.

1,716,632, June 11, 1929, E. D. Gray, E. L. Scofield, and E. C. Defoe (to Standard Oil Co. of Calif.).
Filters acid-treated oil through sawdust.

1,716,973, June 11, 1929, M. G. Paulus (to Standard Oil Co. of Indiana).
Saturates oil with H_2S and then treats with doctor solution in the usual way.

1,716,974, June 11, 1929, E. H. Payne (to Standard Oil Co. of Indiana).
Describes a special filter arrangement for filtering oil through clay.

1,718,218, June 25, 1929, R. Cross (to Cross Development Corp.).
Treats the charging oil with Na_2PbO_2 solution and acid, and then cracks.

1,718,335, June 25, 1929, O. E. Cushman and T. W. Doell (to Standard Oil Co. of Calif.).
Method of making soaps from sulfonated mineral-oil acid sludge.

1,718,375, June 25, 1929, H. L. Pelzer (to Sinclair Refining Co.).
Scrubs the vapors from a vapor phase cracking process with caustic alkali solution and re-cycles the purified heavy condensate. Low S gasoline product is claimed to be obtained from high S charging stock.

1,718,713, June 25, 1929, J. Simpson (to Standard Oil Development Co.).
Treats petroleum distillate with spent doctor solution.

1,718,714, June 25, 1929, L. Link and M. B. Amis (to Standard Oil Development Co.).
Treats cracked distillate with spent alkali to remove corrosive sulfur.

1,723,008, Aug. 6, 1929, A. P. Bjerregaard (to Doherty Research Co.).
Compresses uncondensed vapors from a cracking process and treats with H_2SO_4 to produce alcohols.

1,724,134, Aug. 13, 1929, C. V. Iredell (to Westinghouse Lamp Co.).

Uses small per cent "turkey red oil" in wire-drawing lubricant.

1,725,068, Aug. 20, 1929, G. Egloff and J. C. Morrell (to Universal Oil Products Co.).

Treats cracked products containing S compounds with CuSO_4 in H_2SO_4 solution.

1,725,320, Aug. 20, 1929, M. J. Trumble.

Introduces HCl , H_2SO_4 or other chemical reagent into hydrocarbon vapors in a hydrogenating and cracking process.

1,725,611, **1,725,612**, Aug. 20, 1929, J. C. Black, W. D. Rial, and J. R. McConnell (to Pan American Petroleum Co.).

Removes acid reaction products from H_2SO_4 treated oil by precipitation with pitch.

1,728,059, Sept. 10, 1929, T. C. Heisig (to Galena-Signal Oil Co.).

Treats lubricating oil with H_2SO_4 and solid absorbent.

1,728,156, Sept. 10, 1929, R. C. Wheeler and P. W. Prutzman.

Revivifies packs of solid caustic through which petroleum vapors have been passed, by means of steam.

1,729,615, Oct. 1, 1929, R. W. Hess and J. M. F. Leaper (to The Barrett Co.).

Prepares benzyl mercaptan from benzyl chloride and metal thiosulfate. The decomposition of benzylthiosulfate gives 60% to 75% benzyl mercaptan and 20% to 35% benzyl disulfide.

1,729,782, Oct. 1, 1929, R. M. Isham (to S. B. Hunt, trustee).

Scrubs olefin gas under pressure at below 20°C. with alkyl sulfuric acid, scrubs the residual gas at below 30°C. with a mixture of H_2SO_4 and alkyl sulfuric acid and the residual gas with H_2SO_4 at about 80°C.

1,731,716, Oct. 15, 1929, C. Fischer, Jr. and W. T. Reddish (to The Twitchell Process Co.).

Process of removing oil from mineral-oil sulfonic acids. Also preparation of said sulfonic acids.

1,732,371, Oct. 22, 1929, M. Luther and K. Pieroh (to I. G. Farbenindustrie A.K.H.).

Treats oils with a formate of a low aliphatic alcohol to decolorize and deodorize.

1,732,465, Oct. 22, 1929, F. Gardner.

Uses H_2SO_4 to decolorize hydrocarbons.

1,732,894, Oct. 22, 1929, R. M. Isham (to Doherty Research Co.).

Separates alcohols by agitation with benzene sulfonic acid for differential solubility.

1,732,903, Oct. 22, 1929, S. R. Merley (to Doherty Research Co.).

Separates alcohols by use of benzene sulfonic acid.

1,733,545, Oct. 29, 1929, C. Leaver.

Covers a mixing column for contacting oil with acid or alkali, etc.

1,733,597, Oct. 29, 1929, A. Holmes (to Standard Oil Development Co.).

Treats crude petroleum with fuming H_2SO_4 (20% oleum).

1,733,619, Oct. 29, 1929, J. C. Morrell (to Universal Oil Products Co.).

Treats light distillates with an aqueous solution of an acid sulfate, such as ammonium acid sulfate.

1,733,620, Oct. 29, 1929, J. C. Morrell (to Universal Oil Products Co.).

Stabilizes coke-forming particles of cracking residues by adding an earth metal soap and subjecting the mixture to a homogenizing treatment.

1,733,656, Oct. 29, 1929, G. Egloff and J. C. Morrell (to Universal Oil Products Co.).

Vaporizes petroleum distillate under pressure in the presence of a metallic oxide, condenses the vapors, oxidizes the condensate, and returns the product to the still.

1,733,800, Oct. 29, 1929, E. C. Herthel (to Sinclair Refining Co.).

Treats with solid CuCl_2 in gas and vapor phase.

1,734,959, Nov. 12, 1929, J. C. Black (to Contact Filtration Co.).

Covers apparatus for treating petroleum oils with clay.

1,735,988, Nov. 19, 1929, F. A. Apgar (to Sinclair Refining Co.).

Relates to the passage of petroleum vapors through an adsorptive catalyst such as fuller's earth.

1,736,018, Nov. 19, 1929, C. W. Stratford.

Covers apparatus for contacting oil with treating agents such as acid or alkali.

1,736,022, Nov. 19, 1929, T. deColon Tiff and A. C. Vobach (to Sinclair Refining Co.).

Fractionates petroleum hydrocarbons and then passes the vapors through an adsorptive catalyst.

1,736,234, Nov. 19, 1929, A. C. Vobach (to Sinclair Refining Co.).

Cracks petroleum oil and passes the vapors through an adsorptive catalyst in a combined cracking and treating process.

1,738,330, Dec. 3, 1929, W. M. Stratford (to The Texas Co.).

Treats lubricating oil with acid, separates most of the acid and sludge products, neutralizes, and distils under vacuum.

1,738,518, Dec. 10, 1929, F. C. Axtell (to Axtell Research Laboratories, Inc.).

Distils petroleum oil in the presence of an alkali metal carbonate.

1,739,898, Dec. 17, 1929, E. W. Gard, B. G. Aldridge, and H. J. Multer.

Separates sludge products ("pepper") from acid-treated oil by filtration through foraminous blocks such as "filtros" plates.

1,740,584, Dec. 24, 1929, R. H. Gardner and H. G. Hodge (to Sinclair Refining Co.).

Admits oil containing in solution a metal soap such as a copper resin soap into the flux tower of a still to contact counter current with the vapors rising through the tower.

1,741,206, Dec. 31, 1929, T. H. Stackhouse.

Anti-knock motor fuel consisting of gasoline, CS_2 , and nitrobenzene.

1,741,555, Dec. 31, 1929, M. L. Chappell and G. J. Ziser (to Standard Oil Co. of Calif.).

Treats oil with aniline at elevated temperature, cools, and separates.

1,742,020, **1,742,021**, Dec. 31, 1929, A. H. Ackermann (to Catalytic Chemical Co.).

Treats lubricating oil with mixtures of naphthalene, anthracene, NaOH , phosphate rock, sugar, and oil of mirbane..

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